# **Acronyms and Abbreviations**

BMP Best Management Practice

BNSF Burlington Northern Santa Fe

BOD Biochemical Oxygen Demand

CAO Critical Areas Ordinance

CAP Continuing Authorities Program

CCWF Centennial Clean Water Fund

CCWG Centiennial Clean Water Grant

CDBG Community Development Block Grant

cfs Cubic Feet per Second

City of Wenatchee

CIP Capital Improvement Plan

CMP Corrugated Metal Pipe

Corps U.S. Army Corps of Engineers

COD Chemical Oxygen Demand

CPEP Corrugated-Smooth Interior Polyethylene Pipe

CSO Combined Sewer Overflow

CWA Clean Water Act

DDD Dichlorodiphenyldichloroethane

DDE Dichlorodiphenyldichloroethylene

Ecology Washington State Department of Ecology

EPA Environmental Protection Agency

ESA Endangered Species Act

FCAAP Flood Control Assistance Account Program

FEMA Federal Emergency Management Agency

FIRM Flood Insurance Rate Map

FIS Flood Insurance Study

GIS Geographic Information Systems

GMA Growth Management Act

HDPE High Density Polyethylene

HPA Hydraulic Project Approval

HSPF Hydrological Simulation Program

HUD U.S. Department of Housing and Urban Development

IDDE Illicit Discharge Detection and Elimination

LID Local Improvement District

LID Low-impact Development

LMI Low- to Moderate-Income

LOMR Letter of Map Revision

Manual Department of Ecology 2004 Stormwater Management Manual for

Eastern Washington

MS4s Municipal Separate Storm Sewer Systems

NAD North American Datum

NFIP National Flood Insurance Program

NMFS National Marine Fisheries Service

NOAA National Oceanic and Atmospheric Administration

NPDES National Pollutant Discharge Elimination System

NRCS National Resource Conservation Service

PAH Polynuclear Aromatic Hydrocarbons

PBC Polychlorinated biphenyl

Permit Eastern Washington Phase II Municipal Stormwater Permit

PUD Public Utility District

PWTF Public Works Trust Fund

RCW Revised Code of Washington

SCS Soil Conservation Service

SDC System Development Charge

SDWA Safe Drinking Water Act

SEPA State Environmental Policy Act

SFHA Special Flood Hazard Area

SRF State Revolving Fund

SSO Sanitary Sewer Overflow

SWMM Storm Water Management Model

SWMP Stormwater Management Program

SWPPP Stormwater Pollution Prevention Plan

TMDL Total Maximum Daily Load

TSS Total Suspended Solids

UGA Urban Growth Area

UIC Underground Injection Control

USDA U.S. Department of Agriculture

USFWS U.S. Fish and Wildlife Service

USGS U.S. Geological Survey

WAC Washington Administrative Code

WCC Wenatchee City Code

WDFW Washington Department of Fish and Wildlife

WRIA Water Resource Inventory Area

WSDOT Washington State Department of Transportation

WSU Washington State University

WVSTAC Wenatchee Valley Stormwater Advisory Committee

WWHM3 Western Washington Continuous Hydrology Simulation Model 3

WWTP Waste Water Treatment Plant

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# **Executive Summary**

The City of Wenatchee (City) has proactively addressed stormwater runoff in the urban area for decades. Some of the first stormwater mains were installed over 70 years ago. Today the stormwater conveyance system stretches across the city and includes thousands of catch basins and close to seventy-five miles of pipe. In 1994, the City established a stormwater utility to protect property, provide urban flood control, and fund maintenance and improvements to the stormwater system. A Stormwater Management Plan was completed in 2000 to plan for future development and growth. Since 2000, the City has made significant improvements throughout the stormwater system. New developments have also added stormwater infrastructure as the city has grown west up the hills and canyons. In addition, regulations have changed, thus increasing the level of administration, maintenance, and adding treatment requirements for stormwater.

The City hired HDR Engineering to prepare this update of the 2000 Stormwater Management Plan with Erlandsen & Associates and Clear Water Solutions as subconsultants. This document includes planning and engineering strategies to meet stormwater capacity for the next 6 to 10 years as well as upcoming water quality requirements.

# **Objectives**

The purpose of updating the Plan was to accomplish the following goals:

- Upgrade the City's mapping and Storm Water Management Model into a geographic information system (GIS) format and document system improvements since the last plan to improve asset management.
- Provide the City with a GIS-based model for analyzing planned development and identifying associated stormwater handling requirements.
- Analyze and prioritize improvements to the city's conveyance system.
- Prepare an updated Capital Improvement Plan for integration into the City's stormwater utility budgeting and rate-setting process.
- Look for opportunities to develop basin-specific water quality improvements, including conveyance solutions, consistent with the Clean Water Act's (CWA) National Pollutant Discharge Elimination System (NPDES) Phase II requirements.
- Identify policies for moving forward with mitigation of flood hazards associated with the canyon drainages west of the city in Chelan County.

#### Approach

Through this planning process, the city's stormwater policies and goals were reviewed. Opportunities for addressing flooding from Canyons No. 1, No. 2, and Dry Gulch were evaluated as well as the impacts of new water quality regulations from the National Pollutant Discharge Elimination System (NPDES) Program. Finally, using the Storm Water Management Model and the city's updated stormwater system map, recommendations for system improvements were made for piping upgrades, outfall

improvements, and detention facilities taking into consideration the City's land use and zoning as identified in *Planning to Blossom 2025: Wenatchee Urban Area Comprehensive Plan* (2008).

# **Conclusion & Significant Findings**

Policies and strategies for addressing urban drainage, water quality, canyon drainage mitigation and financial management of the stormwater utility were identified in Chapter 5. New policies were added to encourage low-impact development, comply with NPDES, address flooding from the canyon drains in cooperation with Chelan County, and provide a cost-based, equitable and sustainable utility rate by addressing replacement costs and pursuing grants and low-interest loans.

The results of the hydraulic modeling indicated limited problems in the stormwater conveyance system based on the current configuration. Historical rainfall data for the City of Wenatchee was found to most closely match the Soil Conservation Services Type IA rainfall distribution.

A review of the city's water quality treatment facilities in the stormwater system highlighted the city's recent efforts to incorporate stormwater treatment into road projects such as Walla Walla Avenue, Riverside Drive, and the Hawley-Walnut Street intersection. Basins with future potential for water quality treatment facilities were also noted in Chapter 8.

Capital projects were prioritized based on improvements identified but not completed in the 2000 Comprehensive Stormwater Management Plan, on maintenance records, and on local knowledge of problem areas. When prioritizing projects, HDR and Erlandsen also took into account upcoming road projects and assumed a \$500,000 budget per year for capital projects through 2015. Projects in developed areas received priority over those in undeveloped areas. Chapter 9 provides a description of each project.

# 1 Introduction

The City of Wenatchee (City) has been proactive at addressing stormwater runoff in their urban area for decades. Some of the first stormwater mains were installed over 70 years ago. Today the stormwater conveyance system stretches across the city and includes thousands of catch basins and inlets.

In 1994, the City reinforced its commitment to providing stormwater management services with the formation of a stormwater utility to fund maintenance and improvements in the urban area. A few years later, the 2000 Stormwater Management Plan was completed to plan for future development and growth.

Since 2000, the City has made significant improvements throughout the stormwater system. New developments have also added stormwater infrastructure as the city has grown west up the hills and canyons. In addition, regulations have changed, thus increasing the level of administration, maintenance, and treatment required for stormwater.

The City hired HDR Engineering, Erlandsen & Associates, and Clear Water Solutions, to prepare this update of the 2000 Stormwater Management Plan. This document includes planning and engineering strategies to meet stormwater capacity for the next 6 to 10 years as well as upcoming water quality requirements. The purpose of updating the Plan is to accomplish the following goals:

- Upgrade the City's mapping and Storm Water Management Model (SWMM) into a GIS format and document system improvements since the last plan.
- Provide the City with a geographic information systems (GIS)-based model for analyzing planned development and identifying associated stormwater handling requirements.
- Analyze and recommend new solutions to improve the city's conveyance system.
- Prepare an updated Capital Improvement Plan for integration into the City's stormwater utility budgeting and rate-setting process.
- Look for opportunities to develop basin-specific water quality improvements, including conveyance solutions, consistent with the Clean Water Act's (CWA) National Pollutant Discharge Elimination System (NPDES) Phase II requirements.
- Identify policies for moving forward with mitigation of flood hazards associated with the canyon drainages west of the city in Chelan County.

#### 1.1 Stormwater in Wenatchee

As the city grows, the associated development will convert land into impervious areas such as streets, parking lots, and roof surfaces, which will significantly increase the amount of runoff. In addition, as runoff flows over impervious surfaces, it picks up pollutants and carries them as the runoff flows into a nearby waterbody. Therefore, stormwater management is an important factor in avoiding or reducing flood damage and in protecting and improving water quality and habitat conditions.

# 1.1.1 Flooding

It has been several decades since Wenatchee experienced significant flooding or related damage in its urban area. A major storm has not happened in the drainage basin that surrounds the city since 1972, when 0.68 inch of rain fell in one hour. In May 1993, a local storm reportedly dropped over 1 inch of rain in less than an hour and up to 2 inches in 90 minutes in some areas of East Wenatchee, but this storm missed the urban Wenatchee limits.

# 1.1.2 Previous Studies in the Wenatchee Urban Area and Upland Canyon Drainages

Several drainage reports have been completed for the City of Wenatchee's urban stormwater collection system since 1969. In addition, several flood hazard control studies have been completed in the same period. The following paragraphs summarize these reports.

## **Comprehensive Storm Sewer Plan for Wenatchee Urbanizing Area**

Munson, Nash, Futrell and Associates (February 1969)

This study, which was the first known drainage system study for the City of Wenatchee, focused on the city's urban system only. The U.S. Army Corps of Engineers concurrently completed a separate study of the canyon flows. The planning area was bounded by the Columbia River, Western Avenue, and Crawford Street. Major drainage system improvements were proposed, which included trunk lines in Crawford, Ferry/Russell, Washington, Fifth, Orondo, Springwater, and McKittrick. The sizing for the trunk lines did not consider runoff originating west of Western Avenue.

#### Flood Control of Canyons No. 1 and 2

Department of the Army, Corps of Engineers (November 1974)

Debris-laden floodwater from two canyons west of Wenatchee had historically caused heavy damage in southern and western Wenatchee. A feasibility report recommended constructing reinforced-concrete channels to carry runoff from both canyons through the Wenatchee to the Columbia River. Congress authorized federal funding for the project in December 1970. The Federal project cost was estimated at \$24,440,000 (October 1977 price level). Expenditures for pre-construction planning were \$544,331. Advanced engineering and design studies were deferred pending local agreements to share in project costs. This project was de-authorized January 1, 1990, under the provisions of Public Law 99-662 when the City did not come up with the local share.

# Wenatchee Area Flood Hazard Report for Canyon No. 1, Canyon No. 2, and Dry Gulch

Munson Engineers (March 1980)

The report included a flood hazard analysis and was completed for the Chelan County Public Works Department. It reviewed the feasibility of using debris-control dams in the bottoms of the upstream canyons and detention/infiltration ponds immediately downslope of the canyon openings. The report might have been drafted as an alternative to the Corps' proposed project of 1974.

#### **Phase II Wenatchee Stormwater Study**

Forsgren Associates/P.A. (May 1992)

In this study, a comprehensive analysis of Wenatchee's existing drainage system was completed using SWMM to model hydrology and hydraulics. Modeling was completed

using synthetic rainfall curves rather than actual recorded rainfall data. The study recommended improvements, which were forecasted to cost about \$1.5 million, to upgrade the city's drainage system. In general, improvements were recommended for Columbia Street drainage pipes in vicinity of Benton Street, Miller Street drainage pipes from Springwater to the outfall, Princeton and Maple Street drainage pipes, and various other small pipes scattered throughout the urban system.

# Flood Hazard Investigation of Alluvial Fans below Canyons No. 1 and No. 2 and Dry Gulch

Northwest Hydraulic Consultants, Inc. (July 1996)

This report presents a chronological history of floods from Canyons No. 1 and No. 2 and relates the damage caused by the floods. No recommendations for preventing flooding are made. The investigation did recommend reducing the floodplain limits below the mouths of all three canyons based on hydrologic/hydraulic modeling of canyon runoff and expected deposition of debris. The investigation was used by the City to request and obtain a revised Flood Insurance Rate Map (FIRM) from the Federal Emergency Management Agency (FEMA).

#### **City of Wenatchee Stormwater Management Plan**

Hammond Collier Wade Livingstone (December 2000)

The 2000 plan was a comprehensive stormwater management plan for Wenatchee's urban area. This 2009 plan, which is an update of the plan prepared in 2000, includes new modeling and accounts for city improvements. Upgrades to the city's stormwater system are listed in Chapters 6 and 9.

# 1.2 Analysis of Current and Future Stormwater Conditions in Wenatchee

This section describes how this Comprehensive Stormwater Plan Update addresses stormwater concerns in Wenatchee.

# 1.2.1 Stormwater Analysis Areas of Emphasis

**Hydraulic Modeling:** To prepare this Plan, hydraulic modeling of the city's stormwater system was used to identify problem areas, and modeling was also used to develop various alternatives for alleviating problem areas.

**Water Quality:** In the past few years, the City has taken measures to enhance the quality of stormwater runoff. This Plan provides an overview of the regulatory requirements related to water quality and describes general water quality concerns, pollutant loading, and best management practices (BMPs) and improvements to protect water quality.

**Structural Improvements:** This Plan identifies structural improvements that are necessary to meet the city's stormwater needs. The costs of these improvements and sources of funding are also identified.

Canyons/Dry Gulch Flood Hazard Review and Management Alternatives: The Plan describes the Canyons and Dry Gulch flood hazard conditions, history, and past policies.

#### 1.2.2 Modeling

This document updates the City's existing Comprehensive Stormwater Management Plan by updating the City's mapping and stormwater computer SWMM to reflect improvements since the last plan. Updated hydrometeorological data was used in the modeling, which allow the City to evaluate its stormwater system under a large range of conditions. Various scenarios were also developed for alleviating problem areas.

#### 1.2.3 Information Sources

A variety of local, regional, and state documents were used as information sources for this Plan, including the City's existing Stormwater Plan and the Department of Ecology 2004 Stormwater Management Manual for Eastern Washington (referred to as the Eastern Washington Stormwater Manual, or Manual). The Manual provides guidance on stormwater design and management in eastern Washington, including technical standards and design information for stormwater systems. Section 1.2.2 lists some of the other documents that were used to complete this Plan.

# 1.3 Detailed Planning Goals

The primary goals of this Plan are to provide guidance for managing the City's surface water runoff, protect people and property for urban flooding, and address current and future water quality requirements. In general, the goals and objectives at the start of this study were:

- Update data in the City's current plan, where appropriate, including but not limited to geology, land use, population, topography, vegetation, etc., to fully define the portions of the drainage basins and subbasins that lie in the urban area.
- Review, modify, and refine past models of the city's collection system and update them to a GIS platform.
- Determine the ultimate system of storm drainage components needed to serve growth out to the current urban growth boundary as defined in the City's 2007 Comprehensive Plan.
- Confirm the level of service that the City should adopt and enforce in the management of its stormwater system using alternative analysis, cost comparisons, and computer modeling techniques.
- Perform hydrologic modeling, using SWMM software, to identify surface water runoff peaks, discharges, and volumes for current and future land-use conditions inside the city's current Urban Growth Boundaries.
- Perform analyses of the city's existing urban storm drainage system using existing maps, as-builts, and field verification; calculate conveyance capacities of the system; and recommend routing schemes and/or alternatives for upgrades and extensions inside the study area.
- Provide the City with options for addressing canyon and dry gulch flows.

- Develop a sequenced construction program for the recommended capital improvements.
- Prepare construction cost estimates for proposed capital improvements and identify potential sources of funding.
- Prepare a State Environmental Policy Act (SEPA) checklist.
- Establish a new section in the Plan that summarizes updated stormwater policies, goals, and existing agreements.



Storm event in Wenatchee

# 2 Planning Area Characteristics

This chapter describes Wenatchee's planning area. Location, population, climate, and land use in the city are discussed below.

# 2.1 Planning Area Location

The city of Wenatchee is located in north-central Washington State in Chelan County at the confluence of the Wenatchee and Columbia Rivers. The planning area is the area for which runoff analysis was determined and for which a hydraulic evaluation of the city's infrastructure was conducted. The planning area, shown on Exhibit 2.1-1, includes the current city limits and the Urban Growth Area (UGA), except for the area north of the Wenatchee River commonly referred to as the Sunnyslope and Old Station areas. These areas are not included in the Plan because they are under county jurisdiction and are not expected to transfer to city jurisdiction, according to the 2005 Interlocal Cooperative Agreement for Planning and Coordinating Old Station and Sunnyslope Urban Services and Facilities. If this area comes under city jurisdiction, the Plan will be amended to address the area. The Plan does, however, include the areas west of the city that lie in the No. 1 Canyon, the No. 2 Canyon, and the Dry Gulch drainage basins.

# 2.2 Population

The city of Wenatchee is home to about 30,810 people (OFM 2008a). It is the largest city in Chelan County, which has a population of about 72,100 (OFM 2008a). The city's population is expected to reach about 46,265 by 2025 (OFM 2007 and City of Wenatchee 2007) (see Table 2.2-1). In 2008, Wenatchee had about 12,847 housing units, an increase from about 11,486 housing units in 2000 (OFM 2008b).

Table 2.2-1 City of Wenatchee and Chelan County Population Estimates				
		Year		
	1990 <sup>(1)</sup>	<b>2000</b> <sup>(1)</sup>	<b>2008</b> <sup>(2)</sup>	2025
City of Wenatchee	21,756	27,856	30,810	46,265 <sup>(3)</sup>
Chelan County	52,250	66,616	72,100	100,696 <sup>(4)</sup>

- 1. Source: U.S. Census Bureau as cited in City of Wenatchee 2007.
- 2. Source: OFM 2008a
- 3. Source: City of Wenatchee 2007 states that the city of Wenatchee will grow by 16,945 people between 2025. This was added to the city's 2005 population estimate of 29,320 (OFM 2008a).
- 4. Source: OFM 2007

#### 2.3 Land Use

The Wenatchee city limits encompass about 4,725 acres, and the city limits plus the UGA encompasses about 5,136 acres (City of Wenatchee 2007). A large percentage of the city has been developed into residential, commercial, and industrial land uses. About 60 percent of land within the city's UGA is residential, and about 10 percent is commercial (see Table 2.3-1) (City of Wenatchee 2007). The remaining land is a mix of civic and cultural, industrial, parks and open space, public facilities, resource lands, and

undeveloped land (see Table 2.3-1) (City of Wenatchee 2007). Exhibit 2.1-1 shows the current city limits and UGA, and Exhibit 2.3-1 shows city zoning.

The remaining developable land is generally steeper and/or is located in the bottoms (floodplains) of Canyon No. 1, Canyon No. 2, or Dry Gulch. Infilling and redevelopment will also accommodate part of the future growth. The land-use designations were used to define the potential development that could influence the runoff within the city's urbanized area.

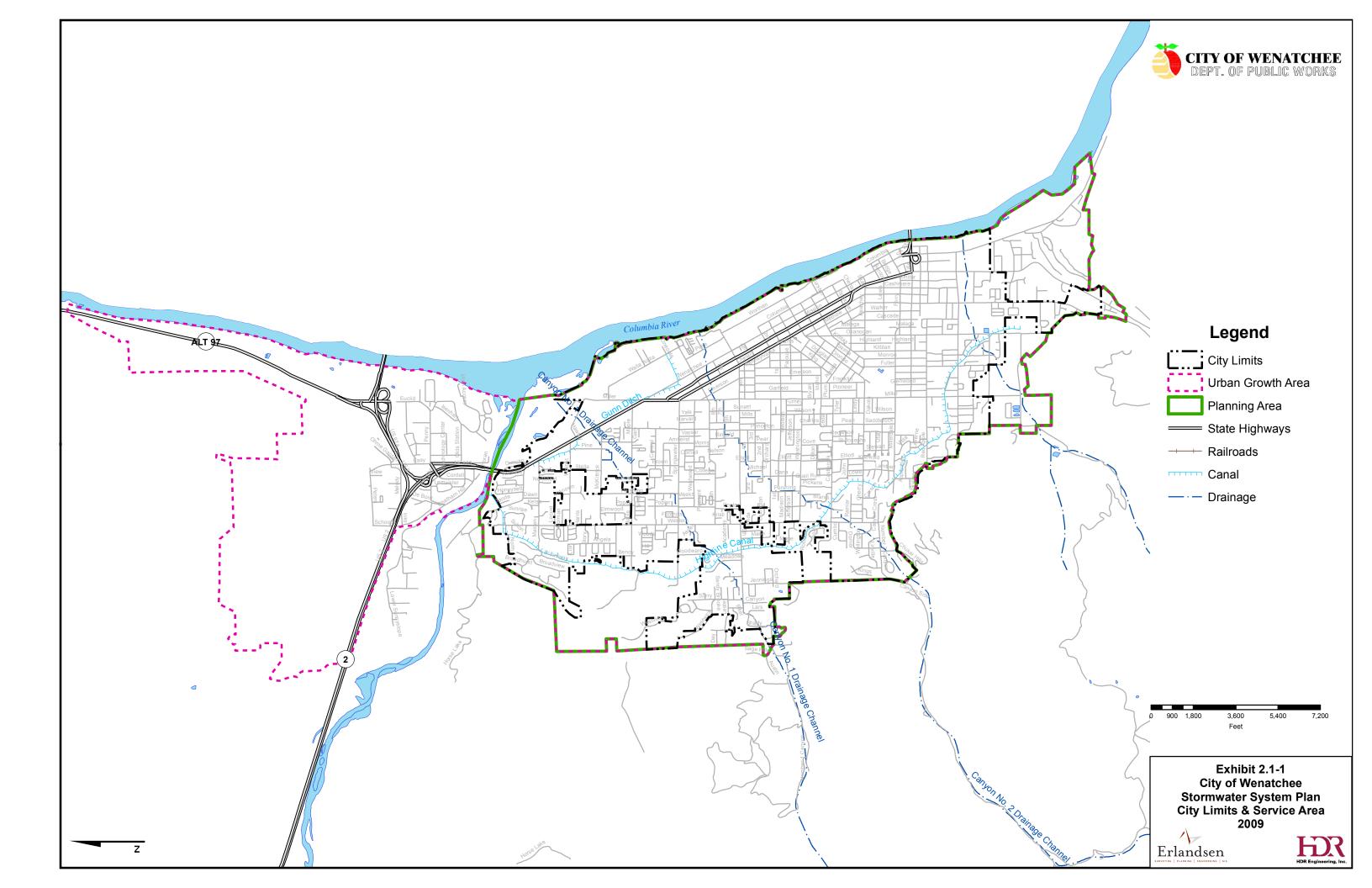
Table 2.3-1 City of Wenatchee Land-Use Inventory (Including UGA) (from City of Wenatchee's 2007 Comprehensive Plan)			
Land Use	Acres	Percent of Total	
Civic and Cultural	78	1.5	
Commercial	538	10.5	
Industrial	216	4.2	
Multi-family	188	3.7	
Parks and Open Space	199	3.9	
Public Facilities	526	10.3	
Resource Lands	206	4.0	
Single Family	2,948	57.4	
Undeveloped	234	4.6	
Totals	5,133	100.1	

Source: City of Wenatchee 2007

#### 2.4 Climate

Wenatchee's climate is relatively mild and arid. Winds prevail from the west and carry marine air across the Cascade Range, where most precipitation falls as rain or snow. Cool temperatures and light precipitation characterize winters, while the summers are hot and dry. Annual precipitation averages 10 to 12 inches (1950 to 2008). Average temperatures range from 20°F in the winter to 90°F in the summer. Intense, short-duration summer thunderstorms occasionally develop along the east slopes of the Cascade Mountains from a southwesterly flow and have caused locally heavy runoff in the Wenatchee area.

The data from three rainfall gauge stations was reviewed to determine recurrent storm magnitudes for the planning area. These stations are a station in downtown Wenatchee, which is a daily recording station; a station on Western Avenue, which is in the middle of the city's urban area and was an hourly station until 1996 but is now a 15-minute station; and a station at Pangborn Airport in East Wenatchee, which is a daily recording station. Available rainfall data for these stations was obtained from the U.S. Department of Commerce; from the Western Regional Climate Center in Reno, Nevada; and from the Washington State University (WSU) AgWeatherNet website. For this study, only hourly data up to 1993 and 15-minute data from 1993 forward were selected for analysis because they are the most accurate and location-sensitive data that could be assembled for the planning area.



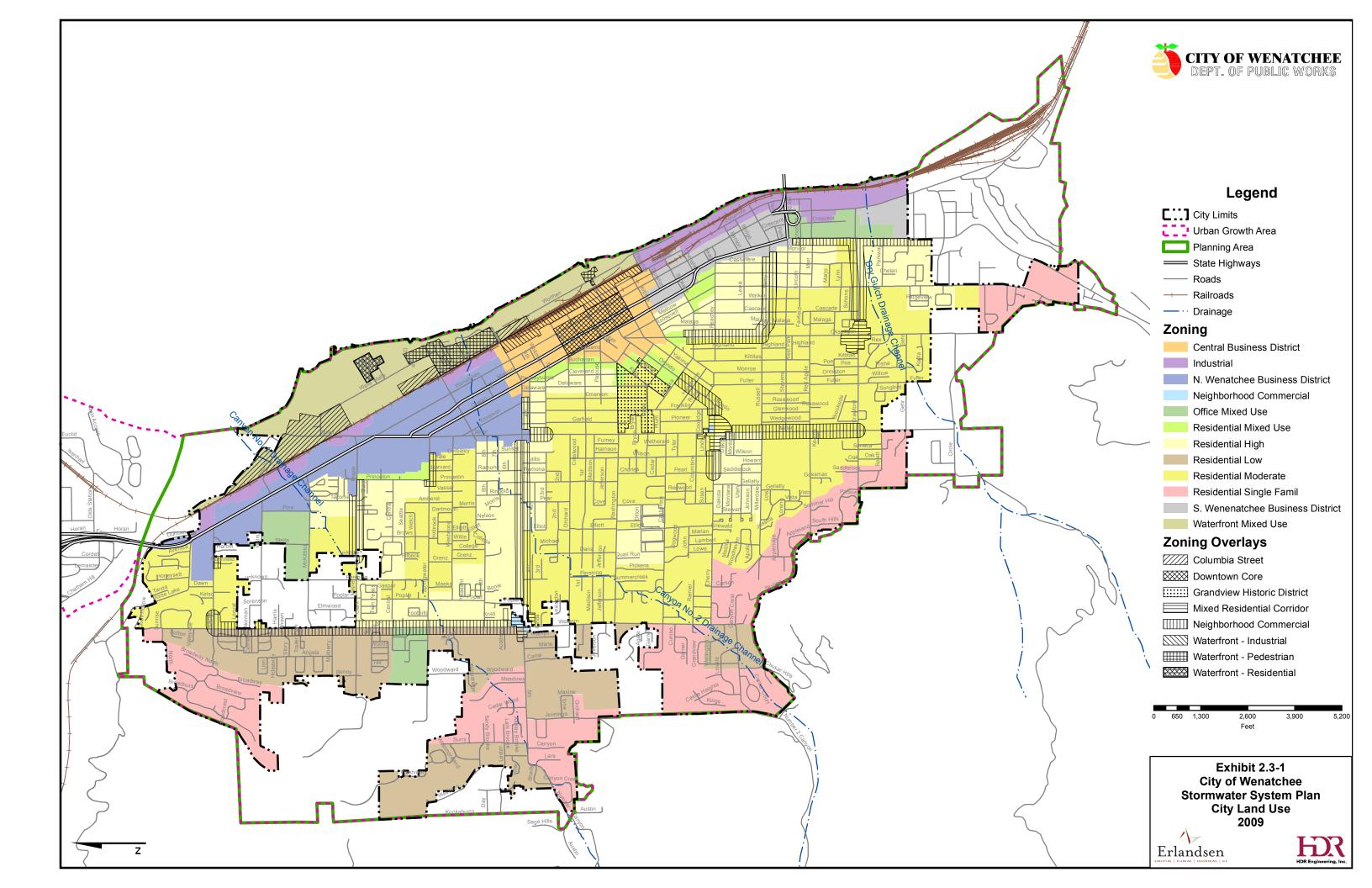


Table 2.4-1 summarizes the maximum hourly precipitation of record for the Wenatchee Experiment Station. The December 3, 2007, storm was discounted after research determined that the actual event consisted of a large freezing rain event as recorded in the Wenatchee World Newspaper. The rainfall volume was redistributed over several hours in the model.

Thunderstorms, which usually occur during the summer, were concluded to generate the highest hourly rainfall intensities within the period and were determined to cause more significant runoff than rainfall or snow melt.

Table 2.4-1 Maximum Hourly Precipitation Events for the Wenatchee Experimental Station from July 1948 through January 2009			
Maximum Hourly Total Monthly Date Reading (inches) Precipitation (inches			
November 24, 1965	1.02	1.17	
August 25, 1956	0.74	1.78	
February 11, 1969	0.73	1.00	
October 31, 1980	0.70	1.80	
January 11, 1972	0.69	1.00	
August 23, 1965	0.68	1.43	
June 9, 1972	0.68	1.47	
December 3, 2007 0.44 1.41			

Source: Western Regional Climate Center and WSU AgWeatherNet

# 2.5 Topography

The topographical information for the urban area used in this Plan was obtained from the City of Wenatchee Planning Department. The information was prepared based on the U.S. Geological Survey (USGS) North American Datum (NAD) 83.

Topographical information for the western boundaries of the planning area and the canyons' drainage basins was taken from electronic records available from the Chelan County GIS database. A topographical map is presented as Exhibit 2.5-1.

The topographical features of the urban planning area include moderately sloping benches that are about 2.5 miles across from west to east and about 3 miles long from north to south. The benches slope from the southwest to the northeast. They are bounded by the Columbia River on the east, the Wenatchee River on the north, Squilchuck Creek on the south, and the Mission Ridge Mountain foothills on the west. The southwestern margin of the benches, which were formed by coalescing alluvial fans, has an elevation of 1,000 feet at the mouth of Dry Gulch and similar elevations at the mouths of No. 1 and No. 2 Canyons. The upper bench elevation diminishes to 900 feet at a point immediately south of the Wenatchee River. The benches slope from 2 to 3 percent to the east toward their intersection with the Columbia River, which has a normal pool elevation of 606 feet.

The benches include the majority of the existing developed urban area. As they rise in elevation, the benches transition into the mountainous foothills to the west, which are just beginning to be developed for suburban land use.

There are three canyon drainages on the east slope of Mission Ridge that outfall to the city's urban area; these drainages cover about 20 square miles in total area. The elevation of the drainage divide at the head end of the basins is about 3,500 feet. The drainages are well incised as they descend to the western upper margins of the benches. Each drainage is less than 6 miles long and generally drains from west to east, where it outfalls onto the developed benches described above. The outfall points of all three canyons include alluvial fans where sediment has been deposited naturally over the years.

The topography of the upland canyon drainage basins is steep-sided (from 45 percent slopes to near vertical), and the basins generally slope to the northeast. The canyon basin slopes are known to have shallow soils covering bedrock. Main channel slopes are generally 5 to 15 percent, and side channel slopes vary between 10 and 30 percent.



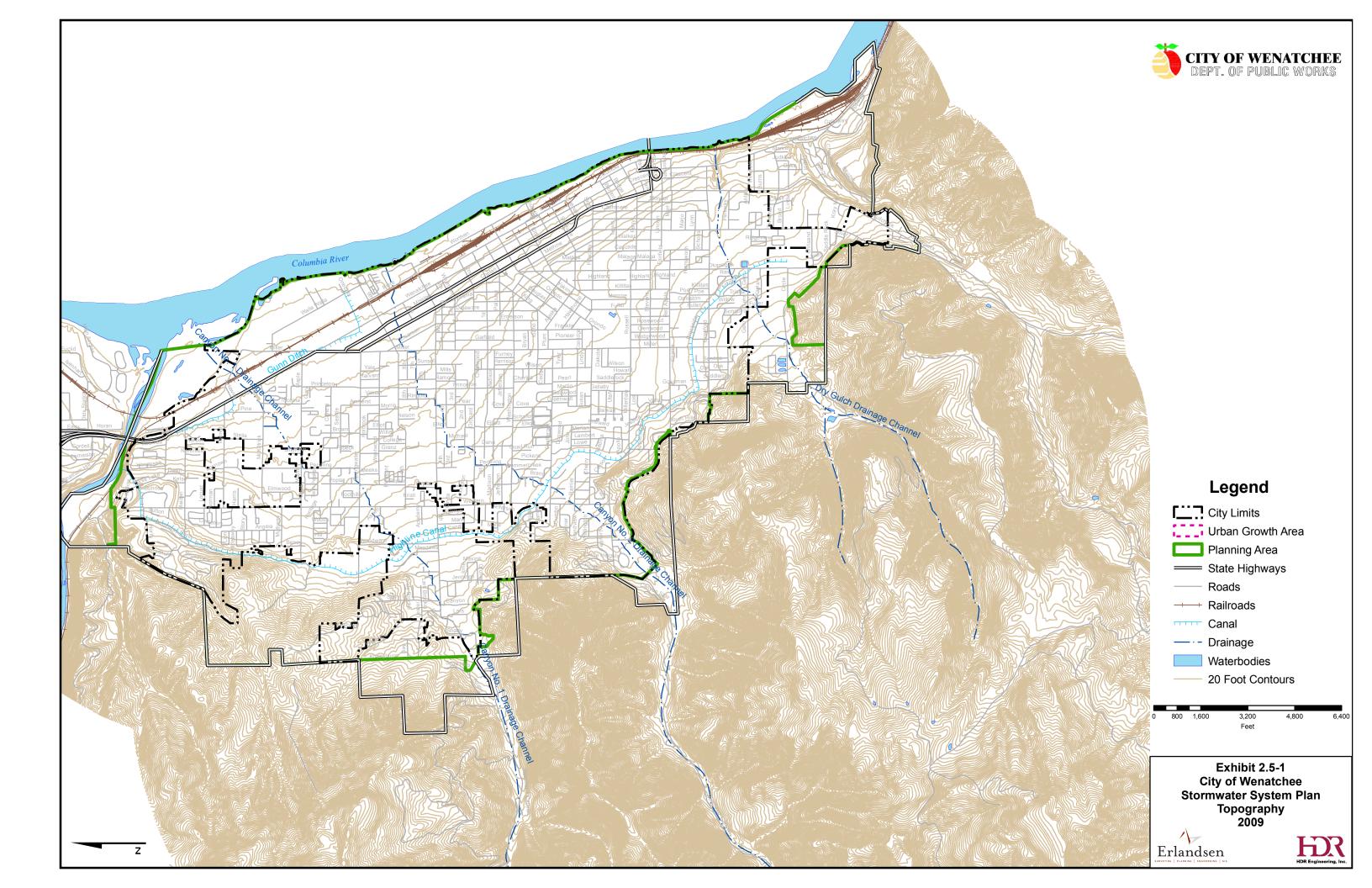
No. 2 Canyon

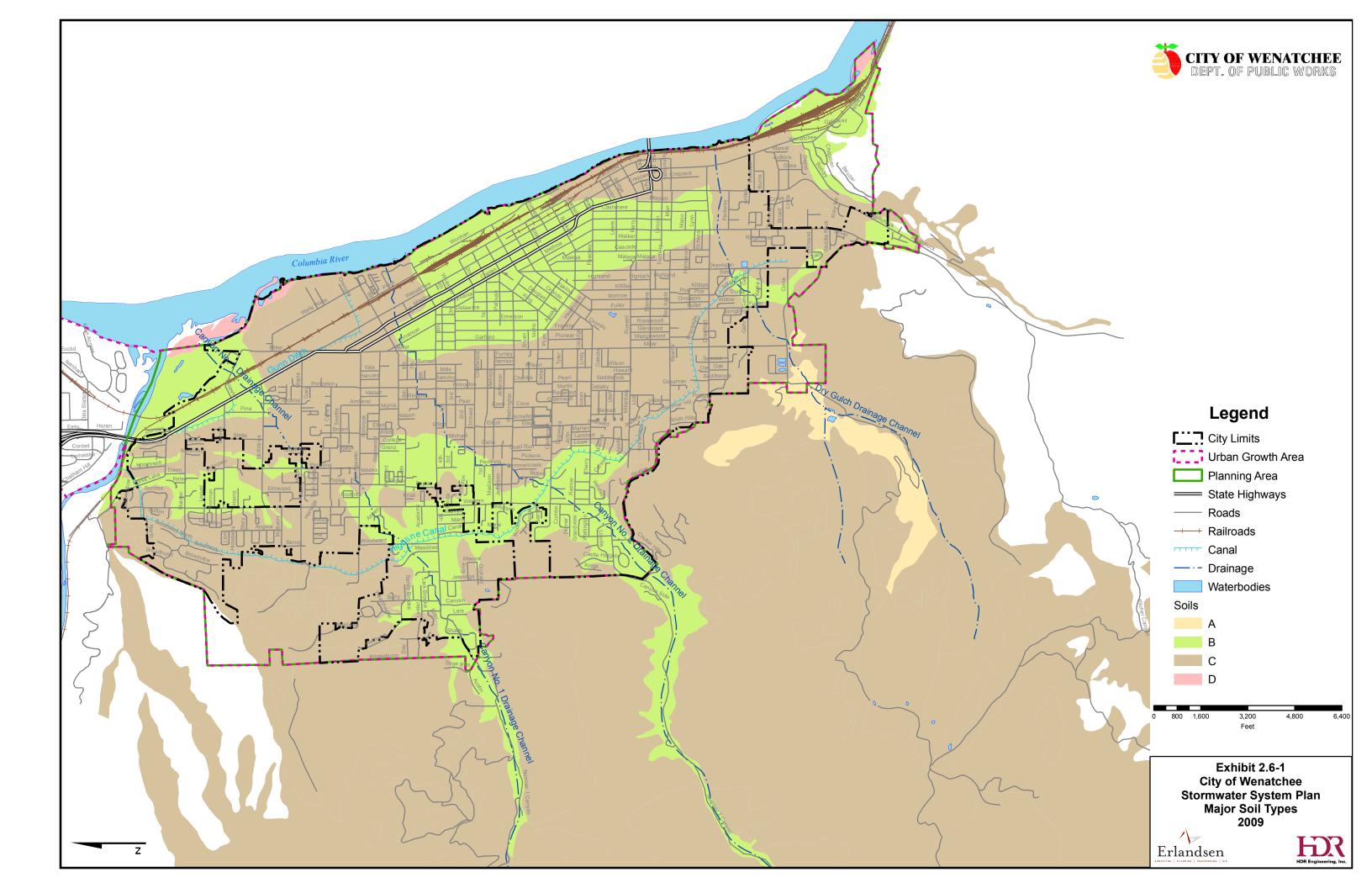
#### 2.6 Soils

The soils in the planning area have been divided into four types based on infiltration rates from the Soil Survey of the Chelan County Area, Washington, prepared by the U.S. Department of Agriculture's (USDA) Soil Conservation Service. Exhibit 2.6-1 shows the four major soil types, which are described below. A detailed narrative description of each soil type can be found in Appendix A.

## Soil Type A

Type A soils are recent alluvial deposits located just downstream from the confluence of the Wenatchee and Columbia Rivers on low areas adjacent to the Columbia River. This





group includes sand, loamy sandy loam types of soils. It has low runoff potential and high infiltration rates even when thoroughly wetted.

# Soil Type B

Type B soils are found in the alluvial fans near the mouths of No. 1 and No. 2 Canyons, in Dry Gulch, on canyon valley bottoms, and on the benches immediately west of the Columbia River. This group includes silt loam or loam. It has a moderate to low infiltration rate when thoroughly wetted.

# Soil Type C

Type C soils are found in both the canyon uplands and in the alluvial terrain within the urban area. They are the predominant soil in the planning area. This group includes sandy clay loam. They have low or slow infiltration rates and moderately high runoff potential when thoroughly wetted.

## Soil Type D

Type D soils are predominantly exposed rock or areas with rock outcroppings. This group includes clay loam, silty clay loam, sandy clay, silty clay, or clay. Group D has a high runoff potential with very low or slow infiltration rates when thoroughly wetted.

# 2.7 Vegetative Cover

The upland portion of the planning area is mountainous terrain with sagebrush cover on its lower slopes and scattered Ponderosa pine on its upper slopes. The lower benches of the planning area are covered with either sagebrush and native grasses (open, non-irrigated areas) or asphalt and urban landscaping, with some parks and orchards present (developed areas).

#### 2.8 Groundwater

The groundwater depth across the lower (bench) portion of the planning area varies from about 15 feet near the Columbia and Wenatchee Rivers to 100 feet near Central Washington Hospital, which is in the southwestern portion of the planning area. There is some shallow groundwater near the foothills in isolated areas, such as the Castle Rock Heights Subdivision. Most, if not all, water supply for domestic and irrigation uses comes from the Columbia River and the Wenatchee River systems or from outside the planning area. There is no known regular use of the aquifer underlying the planning area except for isolated domestic wells and/or for limited stockwatering wells.

## 2.8.1 Aquifer Recharge Areas

It is estimated that the travel time for groundwater in the urban developed bench area to reach the aquifer is significant and possibly many years. This is due to the mostly impervious soils located at deeper depths beneath the planning area. It is also likely that the aquifer under the bench portion of the planning area is the same elevation as the Columbia River pool. It is not recharged extensively by surface water but rather by subsurface flows from the Mission Mountains to the west. Because of these facts, pollutants from stormwater infiltration systems located in the urban area would not affect groundwater aquifer recharge areas to any measurable extent within the planning area.

# 2.8.2 Municipal Water Supply Wells

Wenatchee and the surrounding municipal area are supplied with drinking water from an aquifer located northeast of the planning area near Rocky Reach Dam. Steel reservoirs at various locations are used to store drinking water in the planning area. Chelan Public Utility District (PUD) No. 1 operates a backup well adjacent to Hawley Street near the Columbia River just east of the Burlington Northern & Santa Fe Railway tracks in the northeast of the planning area. It is located close to the Columbia River.

#### 2.9 Critical Areas

The City of Wenatchee regulates development and activities in critical areas through its Resource Lands and Critical Areas Ordinance (CAO), which was updated in March 2009 (Ordinance No. 2009-11). The Growth Management Act requires that cities and counties protect the functions and values of critical areas, which include wetlands, fish and wildlife conservation areas, geologic hazard areas, frequently flooded areas, and critical aquifer recharge areas. The City's designated critical areas are shown on Exhibit 2.9-1.

#### Wetlands

Exhibit 2.9-1 shows the wetlands in Wenatchee. Under the CAO, development is generally not allowed within a wetland or its buffer zone unless the impact is mitigated. Wetland buffers can be averaged (reduced in some areas and increased in others) if certain conditions are met.

#### Fish and Wildlife Habitat Conservation Areas

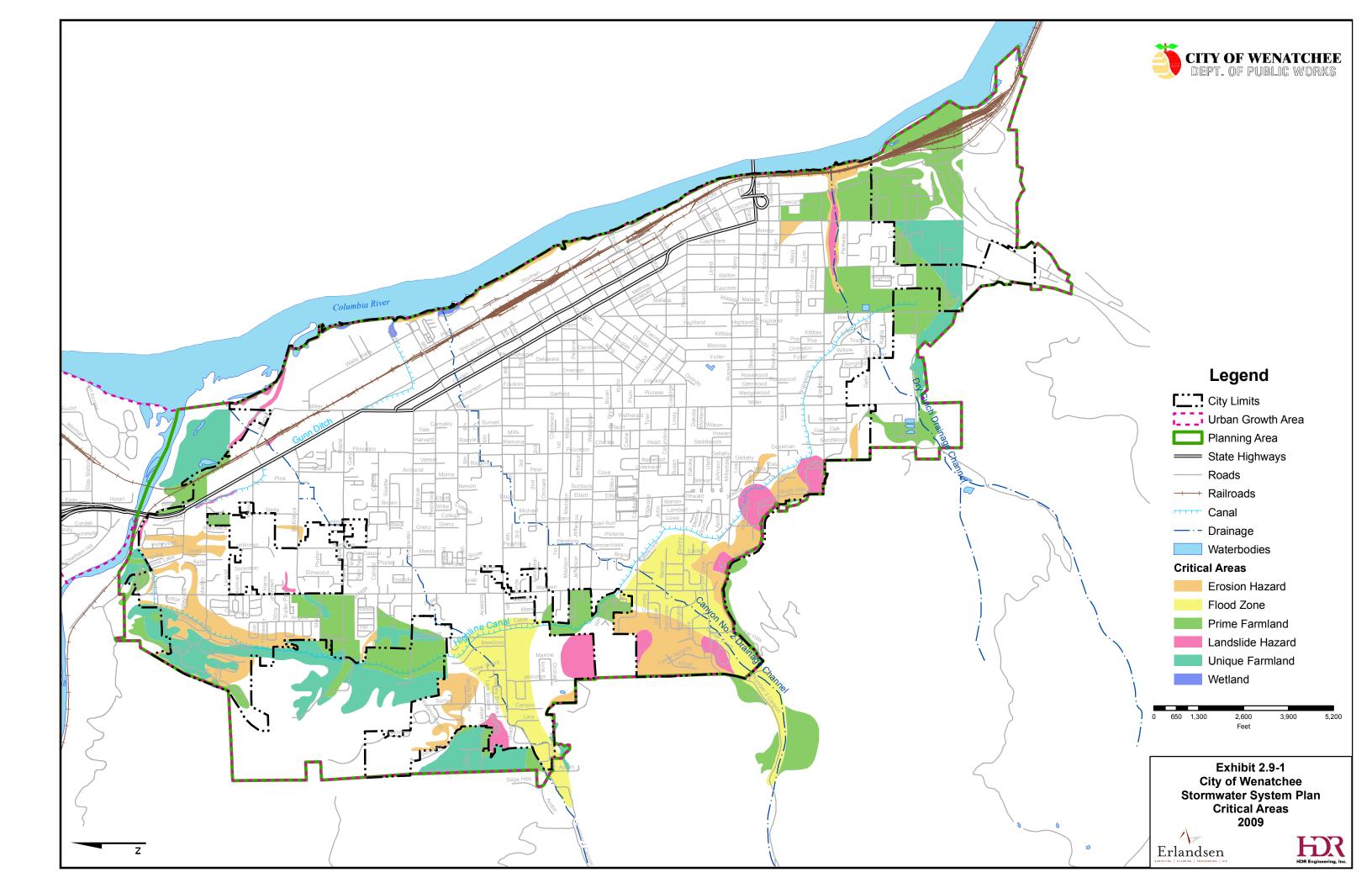
All Fish and Wildlife Habitat Conservation Areas within the city limits are already protected through the city's parks and open space system. However, before any development occurs in the UGA, county maps would need to be consulted to determine if Fish and Wildlife Habitat Conservation Areas are present (personal communication with Brian Frampton, City of Wenatchee, July 23, 2009).

#### **Geologic Hazard Areas**

The CAO regulates geologically hazardous areas, which include erosion and landslide hazard areas. Seismic hazards and other geologic events also fall under the CAO regulation; however, these areas are not present in the city. For erosion hazard areas, a site analysis is required to determine the exact location and circumstances that might cause a significant erosion event. The CAO states that development should be avoided in areas with erosion hazards if mitigation is not feasible, and a buffer should be established from development. Proposed development must also be analyzed in light of the hazards and effects represented by landslide exposure. Documented landslide hazard areas must be avoided as locations for buildings, roads, or utility systems where mitigation is not feasible.

#### **Frequently Flooded Areas**

Exhibit 2.9-1 shows the flood zones within the city. Under the CAO, development must follow the provisions of the Flood Damage Prevention Ordinance, Wenatchee Ordinance No. 2760, including any future amendments.



# **Critical Aquifer Recharge Areas**

Under the CAO, a site analysis is required to delineate critical aquifer recharge areas on a scaled development plan. The site analysis creates a water quality baseline, which serves as a minimum standard that must not be further degraded by development. In addition, the amount of additional impervious surfaces created must be limited to the amount described in the site analysis to ensure that aquifers recharge adequately and water quality is protected. Development must also implement best management practices. There are no known critical aquifer recharge areas in the city.

# 2.10 On-site Sewer Systems

Almost all areas inside the current city limits are served by and connected to the city's sanitary sewer system (refer to Exhibit 2.1-1 for city limits delineation). Conversely, areas outside the city but within Chelan County's jurisdiction are mainly served by onsite septic tank and leach field disposal systems.

# 3 Existing Stormwater Collection System

This chapter describes Wenatchee's existing stormwater collection system, including the stormdrain system and maintenance and operation issues.

# 3.1 Urban Drainage System

Wenatchee's urban storm drain system consists of over 70 miles of drainage pipes that vary in size from 8 to 72 inches in diameter. Exhibit 3.1-1 illustrates the locations of the various pipe sizes in the collection system. Table 3.1-1 summarizes the total lengths of the pipes in the collection system.

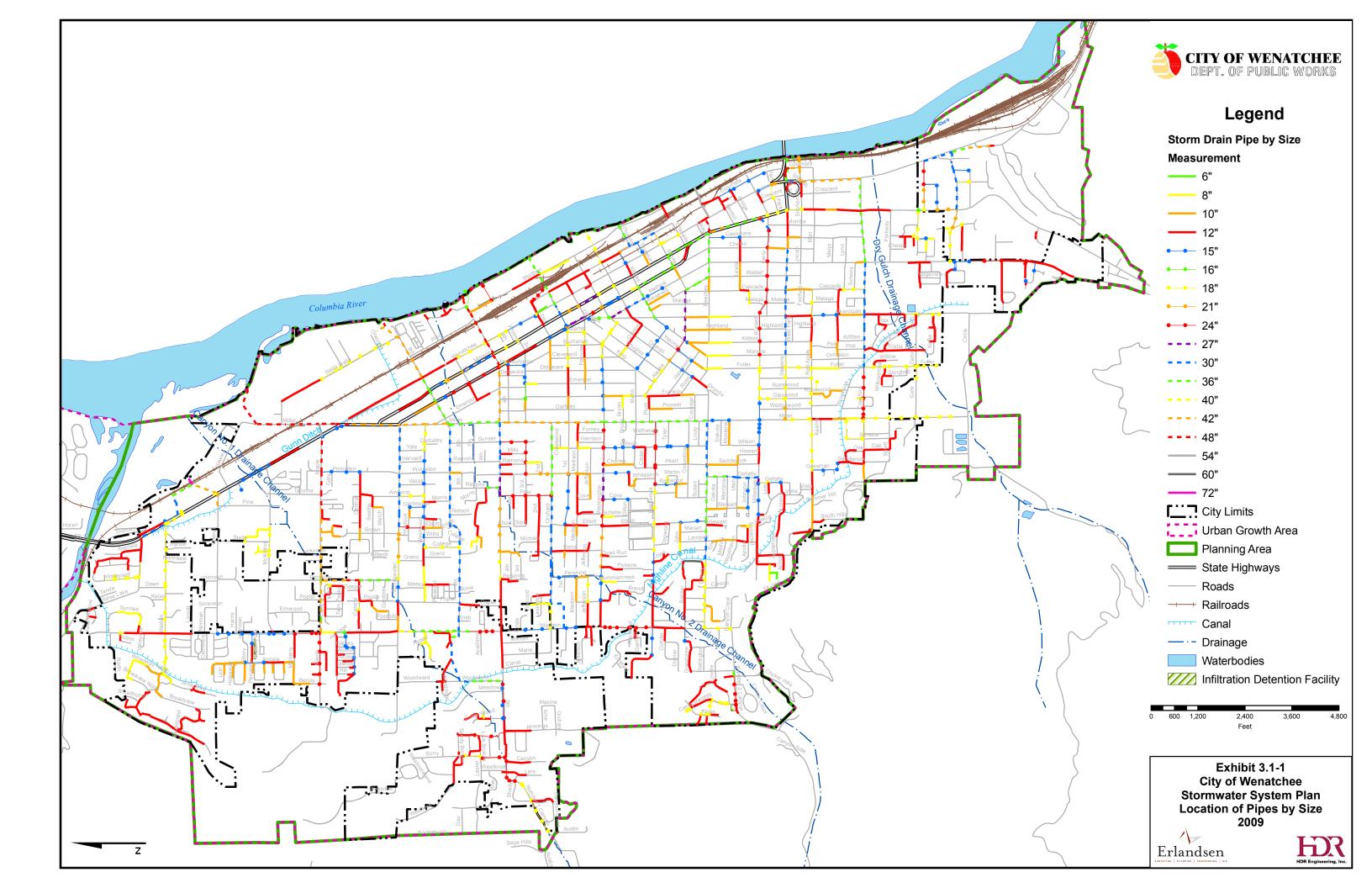
Table 3.1-1 Pipe Sizes		
Size (inches)	Length (feet)	
8	16,980	
10	35,460	
12	122,040	
15	41,760	
18	50,800	
21	9,100	
24	24,300	
27	4,660	
30	30,100	
36	27,280	
42	16,260	
48	8,260	
54	1,180	
60	665	
72	180	

The pipe materials in the collection system include asphalt dipped steel, concrete, corrugated aluminum, corrugated steel, PVC, and high-density polyethylene pipe (HDPE). Table 3.1-2 lists the various lengths of pipe by pipe composition. According to the City's drawings for the storm drain system, the first collection system pipes were installed in 1952. The City has conducted video inspections of all new developments and projects since 1998 and of several problem areas. Over the next few years, the City plans to conduct more video inspections, especially in the older parts of the system, to assess the condition of the pipes.

Table 3.1-2 Pipe Composition		
Туре	Length (feet)	
HDPE	167,600	
PVC	29,570	
Concrete	67,600	
Dipped Steel	46,000	
CMP	67,600	
Aluminum	2,800	
Asbestos Concrete	7,850	

The City has completed several upgrades to the collection system since the 2000 Report was finished. The following improvements were completed and have been integrated into this analysis:

- Ninth Street Upgrades to the collection system between Miller Street and Western Avenue and from Miller Street to Wenatchee Avenue have upsized the collection system to increase flow capacity.
- Fifth Street (Woodward Drive to Surry Road) Construction of a parallel collection system has increased the conveyance capacity in the area west of Woodward Drive.
- Woodward Drive A new line was constructed to connect the Fifth Street improvements to the Ninth Street improvements. This line diverts flows from the existing Fifth Street collection system west of Western Street and into the Ninth Street collection system to alleviate capacity issues.
- Orchard Street Improvements in this area have increased flow capacity and further developed a complete collection system.
- Crawford Street These improvements have removed discharges from the Dry Gulch drainage course into Crawford Street and routed them to the Columbia River through an existing outfall. In addition, the pipe size on Crawford Street and Snohomish Street was increased in this project. A 24-inch main was added on South Mission Street from Parkway Avenue to Crawford Street.
- Western Avenue and Maiden Lane The storm system was expanded to improve stormwater collection in the area during a stormwater improvement project.
- Sunrise Circle A new system was installed to expand the collection system in an area previously prone to flooding.
- No. 1 Canyon Drainage A stormwater system was installed on Fifth Street from the north entrance of Shady Lane to Surry Road. On Surry Road, a new main was installed from Westwick Road to Fifth Street.
- Maple Street A new system was installed from Western Avenue to North Miller Street on Maple Street.
- Walnut Street and Hawley Street During road improvements, bio-infiltration swales were added on Walnut Street from Pine Street to North Wenatchee Avenue, as well as a retention pond.
- North Miller Street Installed 535 feet of 60-inch HDPE pipe to replace failed corrugated metal pipe from North Miller Street across private property (Stemilt, Inc.).
- North Wenatchee Avenue Stormwater System Redirected the effluent from the swales to a dry pond east of the Burlington Northern Santa Fe Railway.
- South Miller Street Improvements An 18-inch main was installed on South Miller Street between Stevens Street and Millerdale Avenue.



#### 3.1.1 Subbasin Delineation

The urban drainage system was divided into 12 separate subbasin systems as shown on Exhibit 3.1-2. Each of the subbasin systems drains to either the Columbia River or Squilchuck Creek through one or more outfalls. The subbasin systems are defined as M-1, M-40, M-70, M-100, M-150, M-200, M-330, M-500, M-700, M-800, M-5000, and M-6000. The "M" designations refer to model numbers (used in runoff calculations), and the numeric portion refers to the beginning pipe number in any subbasin, which was the point of beginning for computerized modeling of the hydrology and hydraulics of the subbasin.

Subbasins were also assigned to the canyon drainages, but only for cursory modeling purposes (the Canyons and Dry Gulch are addressed in Section 3.3).

## 3.1.2 Manholes

The storm drain system typically includes manholes in the piping system at all changes in alignment and at periodic intervals for access and maintenance purposes. Manholes are typically spaced between 350 to 500 feet apart. The City's goal is to space manholes every 300 feet. In a few locations, such as the Wenatchee Avenue core business district, manholes have been omitted, and piping was designed to go from catch basin to catch basin along each side of the street. There are bricked and rocked manholes in the older sections of the system. In addition, the City's past and current practice has been to channelize manholes to provide better flow characteristics and reduce the number of structures requiring sediment removal.

#### 3.1.3 Inlets

Previous field work completed during the 2000 Report shows that many existing inlets in the urban drainage system flow from gutters into subsurface piping. The City has been working during the past 5 years to replace these structures with catch basins. The remaining inlets have been found to fit into two categories:

- 1. Those with no facility for sediment deposition or storage (called *inlets* in this Plan)
- 2. Those with modern sediment deposition and storage function (called *catch basins* in this Plan)

The field inspection found that many catch basins and inlets needed maintenance because they were full or nearly full of sediment. Over the past 10 years, the Public Works Department has been improving its maintenance program to clean the catch basins and inlets. Prior to 1998, the City cleaned structures only when problems were discovered.

The spacing of catch basins in the city's collection system is typically 350 to 450 feet on streets where the storm drainage system has been fully developed. Inlet spacing is governed by design to ensure that runoff from the design storm is captured.

While inlets and catch basins are structurally very similar, there is a wide variation in the grate configurations. On older inlets, grates are round with an inset diameter of about 24 inches or rectangular with an inset dimension of 9½ inches wide by 24 inches long. Patterns of slotted openings in either grate are rectangular with rounded edges.

Grates on modern catch basins are rectangular. Sizes are typically 20 by 24 inches. Patterns of slotted openings are one of the following five configurations:

- Herringbone
- Three-row rectangular
- Two-row rectangular
- One-row rectangular
- Vaned openings

There are very few grates with vaned openings. The herringbone configuration is the most common. The City's goal has been to replace inlets with catch basins to increase sediment removal at the source.

#### 3.1.4 Drywells

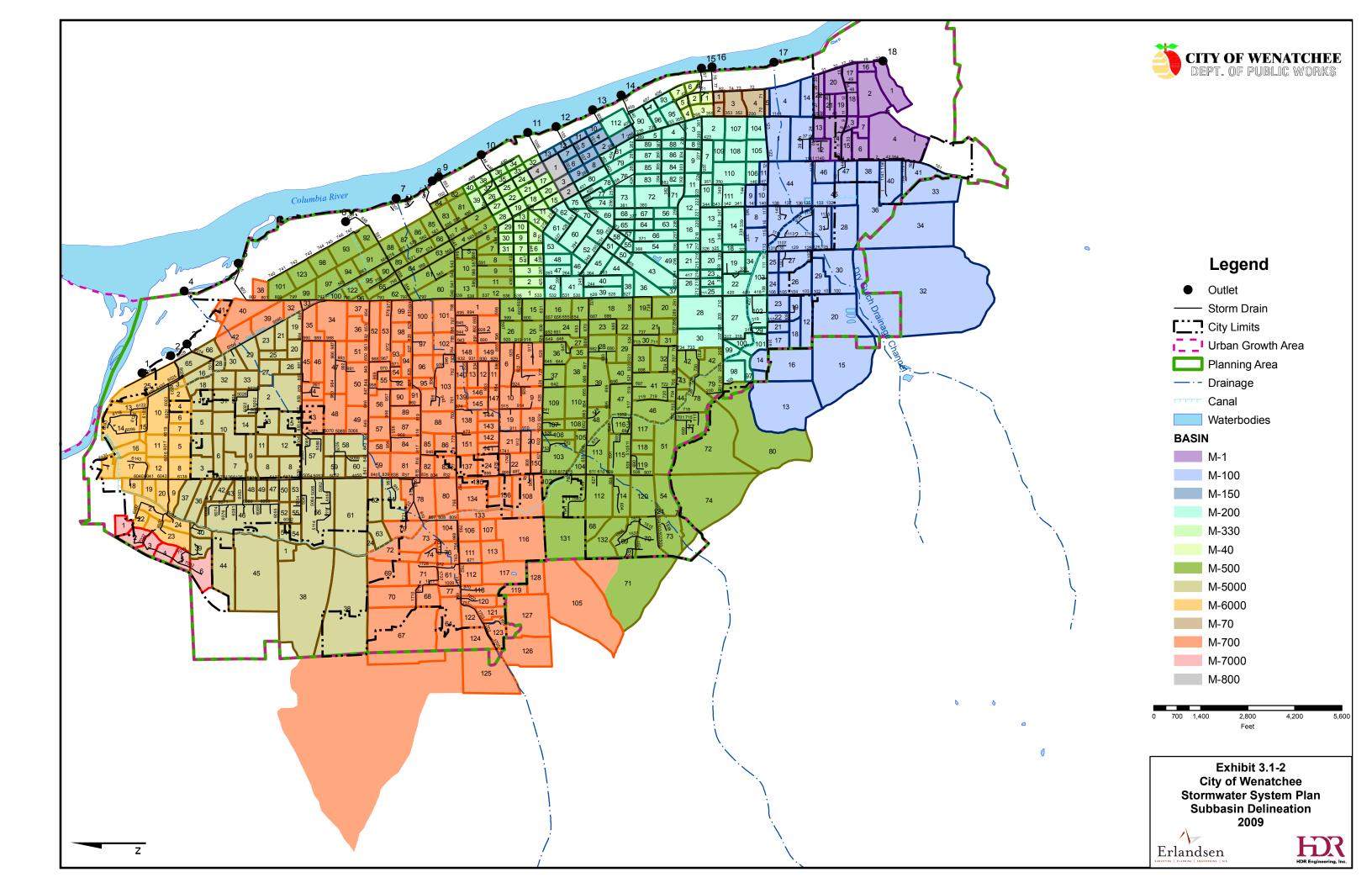
In certain areas of the collection system, drywells were installed to infiltrate stormwater. The locations of all known drywells are shown on Exhibit 3.1-3.

Erlandsen did not evaluate the existing drywells or their typical design. The drywells were probably designed with subsurface gravel beds where stormwater could pond until it is infiltrated into the surrounding soil. Many drywells that were installed in the last 20 years in the Greater Wenatchee area have become ineffective because limited design safeguards to control sediment and lack of maintenance have allowed sediment to be deposited in the gravel beds. Drywells are regulated under the State's Underground Injection Control program, which is described in Section 4.8.

#### 3.1.5 Facilities

#### **Detention Facilities**

Several existing detention facilities in the urban area were designed and constructed to meet permitting requirements as a part of subdivision or commercial development approvals. All were constructed in the last 20 years. Table 3.1-3 summarizes the critical design information for these facilities.



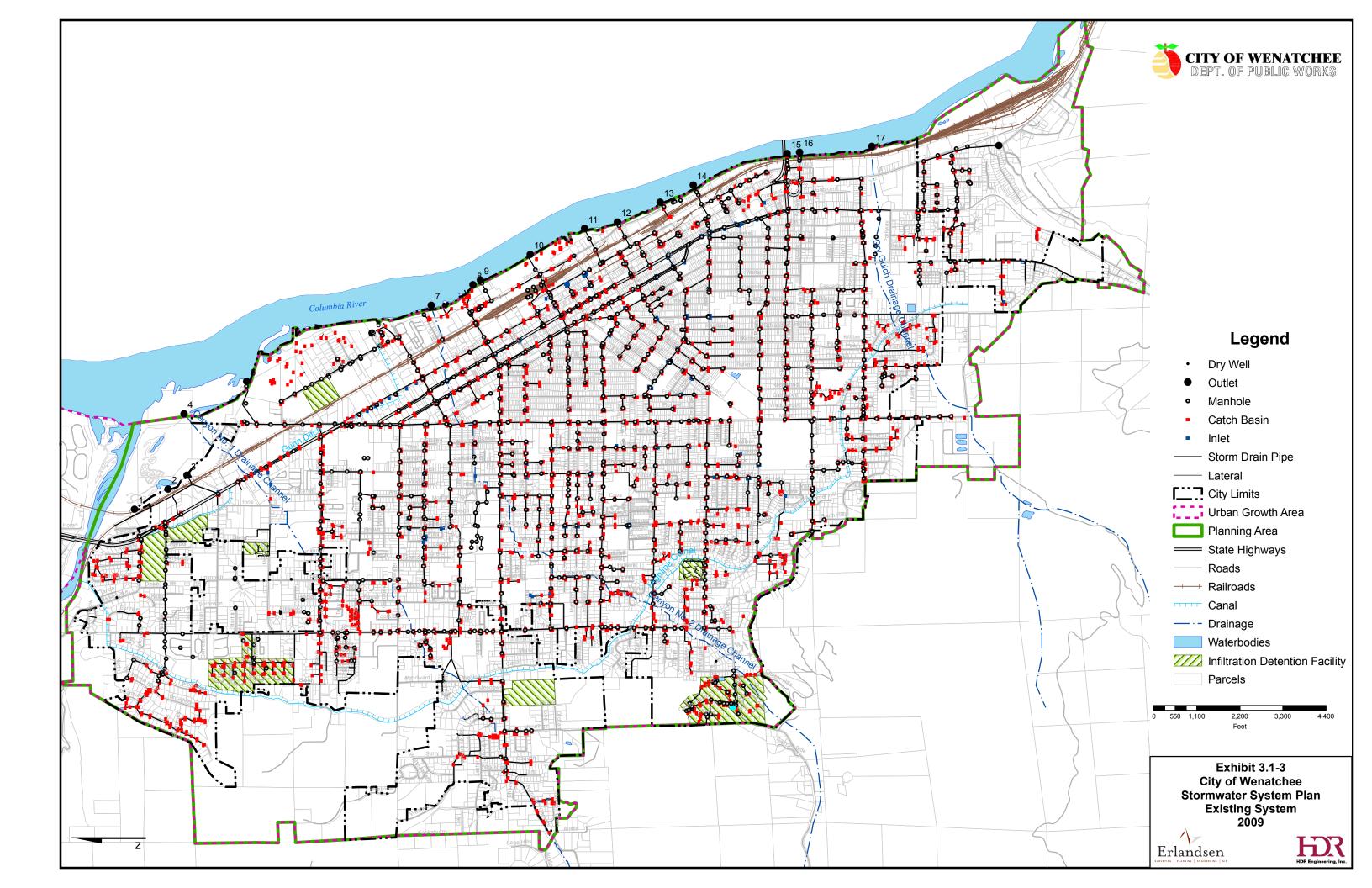


	Table 3.1-3 Existing Detention Facilities
Location	Size/Information
Castle Heights Drive & No. 2 Canyon Rd., Tract "C" (Castle Rock Heights Subdivision)	23,500 ft <sup>3</sup> capacity – access is unrestricted. Overflow to No. 2 Canyon drain system.
Linville Drive, Tract "B" (Castle Rock Heights Subdivision)	53,550 ft <sup>3</sup> capacity – access is unrestricted. Overflow to No. 2 Canyon drain system.
Western Avenue & Story Lane (Western Heights Subdivision)	About 200' × 30'. Access is problematic due to private property restrictions. Couldn't measure depth. No overflow to existing storm drain system.
Wenatchee Avenue & Maiden Lane (East of Wal-Mart parking lot – Wal-Mart Detention Facility)	80,350 ft <sup>3</sup> capacity at overflow. About 248' x 54' x 6'. Access is unrestricted. Overflow to Gunn Irrigation Ditch.
Home Depot	Underground detention facilities.
Town Toyota Center	Total storage of 44,098 ft <sup>3</sup> is developed within the project site through a combination of underground storage facilities and surface depressions. Predeveloped flows discharged to Walla Walla system.
Center Court	Underground storage facility, very large diameter pipe of about 8' diameter and unknown length.
Saddle Rock Ranch Subdivision	Infiltration pond with storage capacity of 12,996 ft <sup>3</sup> . Overflow goes to Methow Street storm system.
Quail Hollow Lane	Two ponds pick up the flow from Quail Hollow, with the first pond picking up the west end of the road and the other picking up the east end of the road. The first pond can flow into the second using a 1.5" orifice to convey water. There is a 1' × 6' wide dead zone in the bottom of each pond, and the overflow from the second pond flows to Lower Horselake Road and ultimately to the Wenatchee River. The first pond is 78' long, and the second 58' long.
Broadway Place (Broadview on the Canal Subdivision)	Trapezoidal basin with bottom dimensions 132' long $\times$ 10' wide and 3H:1V interior slopes.
Maiden Lane (Broadview V–IX Subdivisions)	Storm system drains to an infiltration pond in the canyon that flows to Lower Horselake Road. Infiltration pond has 891 ft <sup>3</sup> of dead space before flowing through an orifice and 6,064 ft <sup>3</sup> of live storage before reaching emergency overflow.
Cedarwood II Subdivision	Infiltration pond about 25' x 23' x 4' deep. Pond has no outlet.

The facility located off Maiden Lane could be considered problematic, since it is located where access for maintenance or emergency repairs is severely limited. Access to the other facilities is not limited. Three of the four facilities are fenced. The newly constructed Town Toyota Center uses an underground infiltration system with a pretreatment device.



Wal-Mart Detention Facility



Wal-Mart Grassy Swale

#### **Pretreatment Facilities**

Roadway reconstruction projects completed within the last 4 years have included facilities that pretreat stormwater before it is discharged into the city's drainage collection system. Systems have been constructed along Walla Walla Street and Hawley Street and will be included in the new Riverside Drive roadway, which will be constructed in 2009. These systems have been constructed such that water that flows off the roadway is discharged into roadway swales between the curb and sidewalk. Stormwater from low-volume storms is allowed to build in the ditches to a depth of 6 inches. If stormwater exceeds the 6-inch depth, flows discharge into an underground infiltration system. Overflows from high-flow storms discharge into a main collection system through overflow catch basins located within the same swale.

Storm filters are also installed on Fifth Street, Riverside Drive, and Pierre Street. In addition, stormwater from the North Wenatchee Avenue basin discharges into a series of swales that provide water quality treatment and infiltration. These swales are located along the Burlington Northern Santa Fe Railway.

#### **Commercial and Industrial Collection and Treatment Facilities**

The planning area does not have any significant industrial facilities. None of the facilities have on-site treatment or detention facilities, and few have on-site collection facilities. There are several fruit-packing sheds on the north end of the planning area. Drainage from older facilities is generally not contained on-site but rather is allowed to flow off-site to city streets before it is collected and routed to storm drain inlets. However, some

newer facilities route site drainage to designated inlets on private property that are connected by pipes to the city's storm drain system.

The Burlington Northern & Santa Fe Railway has a depot on south Columbia Street where maintenance machinery is staged. There are also fruit-packing facilities and auto repair facilities in the general area. Stormwater from these facilities generally flows east to ditches along the railroad tracks and/or to off-site locations (city streets) where it is directed to stormwater inlets.

Commercial properties in the planning area have limited on-site collection or pretreatment devices, if any at all. The shopping mall near the intersection of Wenatchee Avenue and Miller Streets has a limited on-site collection system for the large parking lot. More recently, developed commercial properties, such as Wal-Mart and Home Depot, have been required to provide on-site collection and treatment facilities.

The numerous commercial areas with large parking lots, in addition to all of the gas stations, car lots, automotive repair facilities, convenience stores, and fast-food restaurants, could generate pollutants due to the number of vehicles that use them. It is likely that none of the older gas stations have pretreatment facilities such as oil/water separators. Based on system knowledge, the only likely treatment devices at these facilities are spill-control separators at automotive filling stations. These devices consist of a standard catch basin with a downturned elbow or a tee fitting. These devices are used to temporarily trap small volumes of petroleum products, such as overflows from petroleum filling operations.

#### 3.1.6 Overflows

#### **Irrigation Overflows**

Many irrigated orchards in the planning area have established drainage facilities that route their return flows to the city's urban storm drain system and/or to the No. 1 and No. 2 Canyon drain systems.

Irrigation water is principally conveyed from north to south through the planning area by the Highline Irrigation Canal. This canal is managed by the Wenatchee Reclamation District and serves water to urban agricultural users at "turnouts," which are diversions installed in the banks of the canal. The main canal has its own dedicated drain system that is completely separate from either the urban storm drainage system or the Canyons' drainage system.

Secondary drains, which have been installed to convey excess irrigation water or irrigation overflow, drain to both the urban collection system and the canyon drainage system. Overflows of irrigation water are common. The locations of actual points of irrigation inflow are difficult to confirm, and only a few were noted during the field investigation for the Plan update.

#### **Combined Sewer Overflows**

Combined Sewer Overflows (CSOs) are regulated by the Washington State Department of Ecology (Ecology). Municipalities in the state that have CSOs develop a CSO-reduction plan in accordance with state regulations. This reduction plan is approved by Ecology. The City currently does not have a CSO plan. In the past, the city has not had problems with CSOs.

Within the planning area, there are several locations where a CSO could occur. These locations are identified in the 2008 Comprehensive Sewer Plan. Although the city's wastewater treatment plant has been designed to treat the additional stormwater flows from the areas with combined stormwater and sanitary systems, the City's policy has been to separate stormwater and wastewater whenever feasible.

Many buildings in the downtown area of Wenatchee are known to have roof drains that discharge to the city's sanitary sewer system. This situation does not affect the storm drainage system, since it is an inflow to the sanitary collection facility. The City has been active in reducing these connections as resources become available and connections are discovered.

#### **Sanitary Sewer Overflows**

Sanitary sewer overflows (SSOs) could occur when the capacity of a separate sanitary sewer is exceeded, causing an overflow. These overflows normally could occur during storms and would be caused by inflow and infiltration of stormwater into the sanitary sewer system. The sanitary overflows would then be conveyed into the stormwater collection system downstream of any surcharging manhole. There is no historical record of sanitary sewer line surcharging, or significant problems with city inflow, infiltration, or sanitary sewer overflows within the City's service area.

## 3.1.7 Probability of Illicit Discharges

There is always a potential for illicit discharges to the storm drain system. These could include discharges from automotive shops, including grease, oil, and solvents; discharges from car washes; wastes from floor drains in buildings; or sanitary sewer line connections to the storm drain system. The City has established an Illicit Discharge Detection and Elimination (IDDE) program to address this problem. This program is described in Section 4.1.1.

In addition, there is low to moderate probability that the public could dispose toxic household chemicals or fertilizers into the storm drain system. To reduce the occurrence of improper disposal, local waste-management authorities have implemented programs to collect waste chemicals, paints, and oils on specific days during the year. The City's IDDE program partly addresses this risk. Additionally, education materials will be developed as part of the NPDES Phase II program as described in Section 4.1.1.

#### 3.1.8 Infiltration of Septic Tank Effluent or Contaminated Groundwater

All storm sewers were dry when they were inspected during the field investigation for the 2000 evaluation, unless there were irrigation overflows as noted in Section 3.1.6. The City believes that the possibility of either septic tank effluent or contaminated groundwater infiltrating the storm drain system is very low because a very high percentage of the city's urban area has sanitary sewers, and the groundwater table is not naturally found at the depths that storm drain lines have been installed.

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<sup>&</sup>lt;sup>1</sup> The Plan update team modeled runoff in the downtown area without considering any flows that discharge to the sanitary sewer system, so the predicted capacity requirements should be accurate if roof drains are ever routed to the storm drain system.

#### 3.1.9 Maintenance and Operational Issues

In 2007, the City began tracking maintenance and operational issues within the collection system. Maintenance work includes street sweeping, catch basin cleaning, and pipeline cleaning. Streets are swept on a periodic basis in accordance with the City's cleaning schedule, which is coordinated with Waste Management Inc. to ensure that the schedules do not conflict. Vactor trucks are used to clean catch basins and collection pipes. As the trunk line catch basins are cleaned, detailed records are kept on inlet measurements, pipe sizes, and sediment depths.

The City tracks complaints and other operational issues in an electronic file. This file lists drainage-deficient areas and maintenance projects as they are reported by residents or observed by city staff. Depending on the severity of the issue, immediate repairs are scheduled, or the information is catalogued so that it can be addressed along with other improvements in the area when required.

#### 3.2 Outfalls

There are 17 separate outfalls associated with the urban and canyons drainage systems. Sixteen are maintained by the City, and one is maintained by Chelan County. The city outfalls drain to either the Columbia or Wenatchee Rivers. The County outfall drains to Squilchuck Creek just upstream of its confluence with the Columbia River.

Three dedicated outfalls discharge canyon drainage from the mouths of No. 1 and No. 2 Canyons and Dry Gulch Canyon to the Columbia River. Some urban runoff is discharged to these canyon drains; however, the volume is minor. Since 2000, the City has completed several projects that have removed urban runoff from the canyon drains, including the projects on Fifth Street, Crawford Street, and Maple Street.

Of the 17 outfalls, four discharge to open ditches that could have downstream impacts. Exhibit 3.1-3 shows the locations of all 17 outfalls. Table 3.2-1 summarizes the outfalls and their characteristics.

Table 3.2-1 Existing Wenatchee Urban Stormwater Outfalls				
Location	Estimated Diameter (inches)	Downstream Erosion Potential	Comments	
Urban Flows – Squilchuck C	Creek			
Appleyard (Squilchuck Drainage)	48	Pipe discharge is underwater	Headwall assembly in west side of switchyard (not visible)	
Urban Flows – Columbia Ri	Urban Flows – Columbia River			
Snohomish Street at Columbia River	21	Pipe discharge is under water	21" diameter from city records	
At South Columbia River Bridge	30	Pipe discharge is under water	Installed about 1976	
Outfall between Chehalis Street and Benton Street	54	Outlet under water		

Table 3.2-1 Existing Wenatchee Urban Stormwater Outfalls				
Location	Estimated Diameter (inches)	Downstream Erosion Potential	Comments	
Outfall at east end of Chehalis Street	12	Outfall pipe is clearly visible and discharges down the riverbank across large boulders	Pipe size from city record	
Outfall at east end of Thurston Street	36	Outlet under water	Estimate pipe to have over 20' of cover	
East end of Yakima Street	18	Outlet under water	Small collection system – 6 catch basins/inlets	
East end of First Street	36	Outlet under water		
About 600' south of Fifth Street	24	Outlet under water	Small collection system – 8 catch basins/inlets	
East end of Fifth Street	48	Outlet under water		
About 600' north of Ninth Street (Ninth Street outfall)	42	Outfall into ditch with wetland vegetation through Riverfront Park. Outlet headgate maintains low level backwater pool.	Edges of ditch are landscaped by Chelan County PUD through park to confluence with river. Overflow pipe recently installed with a dissipation box.	
About 1,000' east of Hawley Street/Miller Street intersection (Maple/Miller outfall)	48	Outlet under water		
About 900' northeast of east end of Walnut Street on east side of railroad tracks (Walnut outfall)	72	Discharge into bio swale, then out to wetlands	Overflow only from North Wenatchee Stormwater Facility	
At convergence of railroad lines (north- and westbound) near Wenatchee River	Open Ditch	Discharges into a depression near the Wenatchee River	Shown on maps. Unable to locate in field.	
Canyon Flows – Columbia River				
No. 1 Canyon: Outlet at edge of Orchard north of Hawley Street	36	Outlet to a mature orchard, then overland drainage to wetlands adjacent to Columbia River		
No. 2 Canyon: about 300' southeast of the east end of Islandview Drive	48	Outlet discharges onto rock/concrete rubble	Visual inspection of outlet showed pipe deformed and out of round	
Dry Gulch Canyon – one block south of Crawford Street	48	Pipe discharge is under water	Not visible	

## 3.3 Canyon Drainages

The city's urban stormwater system is separate from the canyon drainages with the exception of a few locations. The City has worked to maintain these natural drainages

when new development occurs and to remove urban runoff. The City maintains sections of these drainage courses only where they cross public right-of-way. In the future, the city's urban stormwater system might be used to mitigating flooding from the canyons.

## 3.3.1 No. 1 Canyon and No. 2 Canyon Drainage Systems

Runoff from No. 1 and No. 2 Canyons to the Columbia River is currently handled by two undersized ditches that meander through the city. The drainage system includes ditches of limited capacity, culvert crossings, and a portion in a closed pipe. The systems provide some drainage relief for storm flows originating in No. 1 or No. 2 Canyons. Ditches start near the mouths of No. 1 and No. 2 Canyons. Both systems drain through the urban area to the Columbia River and discharge at two separate outfall points. The locations of these drainages are shown on Exhibit 3.1-3.



No. 1 Canyon Drainage System



## No. 2 Canyon Drainage at No. 2 Canyon Road

Wenatchee City Code Section 11.24.080 requires that new developments that abut or reroute segments of canyon drains must upgrade the drain to provide conveyance of 100 cubic feet per second (cfs) for No. 1 and No. 2 Canyons and 150 cfs for Dry Gulch. Based on the 2000 plan, the canyon drainage system(s) within the city is (are) constrained by limited maintenance, vegetative growth, and general capability limits. The actual ditch carrying capacity is unknown.



No. 2 Canyon Drainage at Washington Street



No. 1 Canyon Drainage at McKittrick Street

## 3.3.2 Dry Gulch Drainage System

An open ditch with very limited capacity provides the existing drainage for Dry Gulch Canyon. The ditch alignment is shown on Exhibit 3.1-3. Immediately upstream and west of Lincoln Park, the open ditch enters a closed conduit (culvert) at a concrete headwall. From that point to the outfall at the Columbia River, the drainage system consists of a series of buried culverts. The culverts cross under south Mission Street, south Wenatchee Avenue, and the Burlington Northern and Santa Fe Railway tracks en route to the outfall location.



Dry Gulch Drainage near Miller Street

## 4 Regulatory Requirements

There are various federal, state, and local regulations in place to address stormwater runoff. These federal and state regulations are summarized in this chapter. In Washington State, the Washington State Department of Ecology (Ecology) is responsible for developing and monitoring water quality programs in the state. In this capacity, it oversees all stormwater permitting and monitor compliance. It also is responsible for developing a State Stormwater Management Plan that meets U.S. Environmental Protection Agency (EPA) approval.

#### 4.1 Clean Water Act

The Clean Water Act (CWA) implements regulatory and nonregulatory tools to protect water quality in the United States. The major requirements of the Clean Water Act related to stormwater management are stormwater permitting, the 303(d) listing of the Columbia River as a polluted waterbody, and Corps of Engineers Section 404 permits.

## 4.1.1 National Pollutant Discharge Elimination System Program

Under the authorization of the CWA, the EPA implements the National Pollutant Discharge Elimination System (NPDES), which regulates point-source pollution into waters of the United States. In 1990, the EPA developed Phase I of the NPDES Stormwater Program, which requires a stormwater permit for medium and large municipal separate storm sewer systems (MS4s) located in incorporated places or counties with populations of 100,000 or more and for construction activity that disturbs 5 or more acres of land. Phase II of the NPDES Stormwater Program, which was introduced in 1999, requires a permit for stormwater discharges from certain regulated small MS4s and for construction activity that disturbs between 1 and 5 acres of land. The City of Wenatchee is regulated under Phase II of the program.

Ecology administers the NPDES program on behalf of the EPA. On January 17, 2007, Ecology issued the Eastern Washington Phase II Municipal Stormwater Permit (hereinafter referred to as "permit") which authorizes permittees to discharge to waters in Washington in accordance with the special and general conditions listed in the permit. As an owner and operator of a regulated small MS4, the City of Wenatchee is required to obtain coverage under the permit. The permit, which expires on February 15, 2012, contains certain requirements that must be met throughout its duration, one of which is a requirement that owners of MS4s implement a stormwater management program (SWMP) that is composed of the following six minimum control measures:

- Public education and outreach
- Public involvement and participation
- Illicit discharge detection and elimination
- Construction site stormwater runoff control
- Post-construction stormwater management for new development and redevelopment
- Pollution prevention and good housekeeping for municipal operations

The City of Wenatchee coordinated with the City of East Wenatchee, Douglas County, and Chelan County to develop a joint stormwater management program that includes local, semi-regional, and regional activities. Semi-regional and regional activities are those for which the City of Wenatchee partners with one or more of the other jurisdictions. The City of Wenatchee is partnering with East Wenatchee and the Counties for regional efforts such as public education and outreach and is implementing other aspects of the stormwater program locally. A copy of the City's permit application is provided in Appendix B.

Under this program, the City has implemented a program to detect and eliminate illicit discharges into the MS4. The Illicit Discharge Detection and Elimination (IDDE) program is supported by the City's IDDE ordinance, adopted in July 2009, which prohibits certain non-stormwater discharges into the MS4. Other aspects of the program include an Illicit Discharge Detection Plan to find, identify, and eliminate unknown pollutant discharges to the storm drainage system; a spill response plan; public education; and staff training.

Another important aspect of the program is the Construction Stormwater General Permit that is required for construction sites that disturb 1 acre or more and that discharge into waters of the state. This construction permit requires stormwater pollution controls (erosion and sediment BMPs), proper management of construction chemicals and wastes, preparation and implementation of Stormwater Pollution Prevention Plans (SWPPPs), turbidity and transparency monitoring, and various other pollution-management and permit-compliance actions.

## 4.1.2 State 303(d) List and Total Maximum Daily Loads

The Washington State Water Quality Assessment lists the status of water quality for a particular location using Categories 1 through 5. Category 5 waterbodies are those that are included on the EPA's 303(d) list. The 303(d) list is the term for the list of impaired waters that states must submit to the EPA every 2 years. The 303(d) list is of interest in stormwater planning for the City because it establishes noncompliance criteria for the Columbia and Wenatchee Rivers, to which the City discharges stormwater (Squilchuck Creek has not been included on the list). Upstream of the city, the Columbia River is listed because it does not meet the standard for temperature, while downstream it is listed for PCB (polychlorinated biphenyl), 4,4'-DDE (dichlorodiphenyldichloroethylene), and 4,4'-DDD (dichlorodiphenyldichloroethane). The Wenatchee River is listed for PCB, pH, and 4,4'-DDE near the city.

The states use their 303(d) list to prioritize efforts and develop TMDLs. A TMDL, or total maximum daily load, is the maximum amount of pollutant that a waterbody can receive without exceeding water quality standards. In Washington State, TMDL also refers to water quality improvement projects that aim to develop and implement strategies to reduce pollutants in waterbodies that do not meet water quality standards. The TMDL for temperature of the Wenatchee River is the only active TMDL process in the City's permit coverage area that affects storm drainage.

Currently, the Wenatchee River TMDL allocations are being developed for point and nonpoint sources. To comply with these new requirements, wastewater treatment facilities and operations will need to be modified, and land-use practices that contribute to nonpoint pollution will need to be changed. The County has organized a committee to work with Ecology as the TMDL allocations are developed and implemented. The

committee includes the point-source dischargers, the County, the City, and Ecology. The future TMDL requirements will affect Chelan County PUD and other wastewater treatment plant discharges to the river by significantly reducing the amount of phosphorous that can be contributed.

#### 4.1.3 Section 404 Permits

Section 404 of the CWA regulates the discharge of dredged, excavated, or fill material in wetlands, streams, rivers, and other U.S. waters. The U.S. Army Corps of Engineers (Corps) is the federal agency authorized to issue Section 404 permits for certain activities conducted in wetlands or other U.S. waters. Project options in the Canyons and Dry Gulch would likely require a Section 404 permit, since almost all waters are considered to be waters of the United States.

Section 404 of the CWA requires the Corps' approval before an agency takes an action that would discharge dredged or fill material into the waters of the United States, including special aquatic sites such as wetlands. Typical activities that require Section 404 permits are:

- Depositing fill, dredged, or excavated material in waters of the U.S. and/or adjacent wetlands
- Grading or mechanized land clearing of wetlands
- Placing spoils from ditch excavation in wetlands
- Moving soil during vegetation clearing in wetlands
- Depositing fill for residential, commercial, or recreational site developments
- Constructing revetments, groins, breakwaters, beach enhancement, jetties, levees, dams, dikes, or weirs
- Placing riprap and road fill

## 4.2 Endangered Species Act

The Endangered Species Act (ESA) protects threatened and endangered plants, fish, animals, and their habitats. Stormwater management is important to avoid water quality and quantity impacts that can harm threatened or endangered species. The city discharges stormwater to the Columbia and Wenatchee Rivers, which support spring Chinook salmon (endangered), summer steelhead (endangered), and bull trout (threatened). The federal agencies with primary responsibility for the ESA are the U.S. Fish and Wildlife Service (USFWS), which manages bull trout, and the National Marine Fisheries Service (NMFS), which manages spring Chinook and steelhead.

## 4.3 Sediment Management Standards

The current state standards for controlling sediment runoff from construction sites are included in Chapter 173-204 Washington Administrative Code (WAC), Sediment Management Standards. This chapter is included as a reference because of the NPDES

Phase II requirement to obtain a construction stormwater general permit from Ecology for developments larger than 1 acre in size. Sediment and erosion control is perceived as a major concern for permitting development activities. The Stormwater Management Manual for Eastern Washington was published by Ecology in September 2004 to provide guidance for stormwater design and management.

## 4.4 Minimum Functional Standards for Solid Waste Handling

The current state standards for disposing of street sweepings from city streets and sludge removed from catch basins are covered under Chapter 173-304 WAC, Minimum Functional Standards for Solid Waste Handling. The NPDES Phase II program stresses maintenance activities including sweeping and catch basin maintenance with appropriate record keeping. The state standards specify which disposal options can be used for the sweepings and sludge because concentrations of heavy metals from automobile exhaust could be present.

## 4.5 Dangerous Waste Regulations

The current state standards for disposing of waste chemicals are in Chapter 1173-304 WAC, Dangerous-Waste Regulations. These are listed here because the NPDES Phase II program includes a requirement for public education and controlling illicit disposal of unwanted chemicals in storm sewers.

## 4.6 Department of Fish and Wildlife Hydraulic Code

The Washington Department of Fish and Wildlife (WDFW) administers the state's Hydraulic Code and Hydraulic Project Approval (HPA) permits. The main function of the code is to protect the state's fisheries resources, including spawning and rearing habitat. Although not directly aimed at the protection of wetlands or floodplains, the HPA is required for any work below the high-water limits of state waters, which often includes work in wetlands and floodplains. The code is included as a reference because extensive reviews would be required if the City proposed any modifications to outfalls in the existing storm drainage system.

## 4.7 Watershed Planning

Chapter 90.82 Revised Code of Washington (RCW), Water Resource Management, sets out the watershed planning process for Washington State. The watershed planning goal is to develop a management plan for each of 62 water resource inventory areas (WRIAs) within the state. The City of Wenatchee stormwater planning area lies mostly in the Wenatchee WRIA, which is No. 45. On the south limits, it abuts the Alkali–Squilchuck WRIA, which is No. 40. Implementation of the Final Wenatchee Watershed Management Plan began in 2006, which includes recommendations to increase water quantity and improve water quality.

## 4.8 Underground Injection Control Rule

The Underground Injection Control (UIC) rule, as required by the federal Safe Drinking Water Act (SDWA), is intended to protect underground sources of drinking water from contamination by waste fluids including the infiltration of contaminated stormwater. In general, many of the same management requirements apply to UIC and NPDES. In

Washington State, the Underground Injection Control Program has two main requirements:

- 1. A non-endangerment performance standard must be met; this standard prohibits injection that allows the movement of fluids containing any contaminant into groundwater (Ecology 2006).
- 2. All well owners must provide inventory information by registering their wells with Ecology (or with EPA, Region 10, if the wells are located on tribal land) (Ecology 2006).

## 5 Goals, Policies, and Agreements

This chapter contains a comprehensive summary of stormwater goals, policies, and agreements incorporated from existing documents or developed as part of this plan update.

#### 5.1 Goals

The City of Wenatchee has four stormwater management goals:

- 1. Protect property in the urban area from damage caused by stormwater runoff and flooding.
- 2. Protect water quality through environmental stewardship,
- 3. Investigate the potential for mitigation of natural flooding from the canyon drainages using the urban stormwater drainage system infrastructure.
- 4. Provide a cost-based, equitable utility rate.

#### 5.2 Policies

Since the last stormwater management plan in 2000, the City has seen increased urban development and changes to stormwater regulations. This update to the 2000 plan builds on existing policies and includes new policies to ensure that the goals of the stormwater utility continue to be met. Provided in Appendix C are the City of Wenatchee Ordinance No. 3025, which establishes the City's utility, and the associated city code (Wenatchee City Code [WCC] Chapter 9.16), which establishes utility policy and regulation.

#### 5.2.1 Drainage and Flood-Control Policies

The existing stormwater utility has the "primary authority and responsibility for carrying out the City's comprehensive drainage and storm sewer plan, including responsibilities for planning, design, construction, maintenance, administration, and operation of all city storm and surface water facilities, as well as establishing standards for design, construction, and maintenance of improvements on private property where these may affect storm and surface water and management" (Ord. 3025 § 2, 1994).

The utility is authorized to own, construct, maintain, operate, and preserve all stormwater infrastructure that now exists and that might be added to in the future by the addition of other existing or construction of storm drainage systems through the same Ordinance.

By design, the city stormwater system conveys urban runoff caused by impervious areas away from homes and businesses to help control flooding in the urban areas during storms. The following policies support the goal of managing urban drainage and protecting property:

1. Continue using the design criteria of containing and conveying the 10-year flood in the pipe and a 25-year flood within the street section.

- 2. Use the Stormwater Management Manual for Eastern Washington published by the Washington State Department of Ecology and dated September 2004 or latest edition thereof including any amendments by the city for stormwater management on new development and redevelopment sites.
- 3. Ensure that stormwater planning efforts are consistent with city comprehensive plans.
- 4. Continue efforts to inform the public about stormwater urban drainage control and how individuals and development affect stormwater.
- 5. Continue encouraging connections to the city's stormwater system for development within the city limits.
- 6. Require extension to the city stormwater system concurrent with development.
- 7. Develop design standards consistent with the guidelines in the Stormwater Management Manual for Eastern Washington, September 2004 (Manual), or latest published date, and any applicable revisions or addendums to that manual. Chelan County Resolution No. 2010-18, which is provided in Appendix D, adopted the Manual by reference. Appendix D also contains Resolution No. 2010-19, which established a construction and post-construction stormwater runoff control program, and suggested design policies.
- 8. Use the Type IA synthetic rainfall event and rainfall depth data presented in this plan to design stormwater facilities for new development and redevelopment of existing properties and site specific designs. Modeling the runoff produced from the 10- and 25-year 24-hour Type IA rainfall event provides a good representation of the respective 10- and 25-year floods in an urban environment.
- 9. Utilize historic data for sizing trunk lines and future comprehensive plan updates.
- 10. Implement effective and efficient operation and maintenance programs. Monitor drainage problem areas and take corrective actions to remedy them as funding will allow.
- 11. Use the results of the comprehensive plan and continuous model to implement a capital improvement program for constructing the appropriate-size stormwater trunk lines.

## 5.2.2 Water Quality Policies

The intent of these policies is to reduce stormwater pollution and protect water quality.

- 1. Continue compliance with the federal CWA and NPDES permits.
- 2. Use the Stormwater Management Manual for Eastern Washington as stated in 5.2.1 (2).

- 3. Continue participation in the Stormwater Technical Advisory Committee. This group of the four local NPDES-governed agencies works together to provide consistent stormwater regulations and practices in the valley.
- 4. Encourage low-impact development practices where feasible through city projects, incentive programs, and development of street standards.
- 5. Encourage land-use practices that limit the amount of impervious surface area.
- 6. Continue to evaluate emerging technologies for feasibility with Wenatchee's stormwater collection systems.
- 7. Encourage the development of landscape and screening standards that facilitate dual use as stormwater facilities and that increase stormwater water infiltration.
- 8. Develop and implement a stormwater program in accordance with the Eastern Washington Phase II Municipal Stormwater Permit.
- 9. Adopt ordinances to reduce stormwater pollution from illicit discharges, construction activities, and the operation and maintenance of post-construction stormwater facilities.
- 10. Require dedication of regional stormwater detention and water quality facilities when new developments or redevelopment projects are required to install facilities in accordance with city standards. The intent of this policy is to provide consistent maintenance of these facilities to ensure proper operation of the city system. Only those facilities with adequate access and properly constructed should be considered for ownership by the city. Site-specific pretreatment facilities will not be accepted by the city.
- 11. Where appropriate, require the installation of source control pretreatment to reduce pollution from sites and as needed to comply with TMDL requirements.

#### 5.2.3 Canyon Drainage Mitigation Policies

The flooding from the natural canyon drainages has not previously been considered as a priority for the stormwater utility's efforts. However, canyon drainage flooding is not likely to occur at the same time as urban area flooding. Therefore, the intent of these policies is to investigate the possibility of using existing urban stormwater drainage infrastructure to mitigate canyon flooding in the urban area. The long-term goals for flood control might be more intensive and could be explored as well. The goals of the canyon drainage mitigation policies are:

- 1. Use existing studies identified in this plan to help develop and implement low-cost and short-term flood-mitigation measures.
- 2. Develop comprehensive flood-mitigation goals.
- 3. Petition Chelan County to develop a flood-control district.

- 4. Seek funding for flood-control projects from state and Federal agencies, including grant funding sources such as Flood Control Assistance Account Program (FCAAP), to develop flood-mitigation measures and projects.
- 5. Eliminate urban stormwater discharges to the canyon drainages.
- 6. Evaluate how the city's stormwater system could be used to mitigate flooding from the canyon drains.
- 7. Pursue opportunities to develop joint-use flood-control facilities such as parks and open spaces.

#### 5.2.4 Financial Policies

The financial goal of the City's stormwater utility is to provide a cost-based and equitable utility rate. To attain this goal, the rate must meet the full revenue requirement of the utility; must be easy to understand and administer; must conform to generally accepted rate-setting techniques; and must provide adequate revenues to meet the utility's financial, operation, and regulatory requirements. The goals of the utility's financial policies are:

- 1. Use the existing rate methodology that has been developed consistent with the surface water management utility industry.
- Rates and charges will be set so that utility operating revenues are equal to the
  operating costs and will allow coverage factors as set forth in bonding requirements.
  Rates and charges should reflect utility capital needs as well as the reserve policy
  goals of the City Council. Rates and charges should also be set to be financially
  stable over time.
- 3. Pursue grant and low-interest loan opportunities for capital projects and NPDES compliance.
- 4. Develop a policy and method for funding replacement of the stormwater system and facilities to create a sustainable rate base.
- 5. Evaluate the introduction of a system development charge (SDC) for new development, changes in land use, or other land-altering activities. This charge will compensate the utility for the additional facility costs due to development.
- 6. Use stormwater management programs/capital improvement plan (CIP) projects when establishing utility rates and charges.

## 5.3 Agreements

#### 5.3.1 Stormwater Discharge Permit

The City of Wenatchee and Chelan County PUD signed a Stormwater Discharge Permit on April 18, 2003. The agreement acknowledges that the City of Wenatchee designed the stormwater system that serves the North Wenatchee Sub-Area to protect a certain wetlands area from runoff and pollutants. The Permit stipulates that the City will notify

the PUD in writing before making any changes to the stormwater system serving this area that would affect stormwater quality or before the North Wenatchee Sub-Area is enlarged. The PUD and the City agree to meet on the request of either party to discuss any changes to this portion of the stormwater system. The permit also states that the City will make any necessary modifications and improvements to the Linden Tree Discharge Point, including measures to provide water quality treatment.

## 5.3.2 Permit for Use of Hydroelectric Project Lands

The City of Wenatchee and Chelan PUD joined into a permit on July 1, 1996. The permit allows the City to use PUD land for the purpose of a stormwater outfall and detention system that is constructed in accordance with plans approved by the PUD.

# 5.3.3 Memorandum of Understanding among Douglas County, Chelan County, City of Wenatchee, and City of East Wenatchee for Stormwater Management Planning

Douglas County, Chelan County, City of Wenatchee, and City of East Wenatchee signed a Memorandum of Understanding on February 3, 2004, agreeing to jointly prepare a work plan for developing and implementing a regional stormwater management program to address the requirements associated with the Eastern Washington Stormwater General Permit issued by Ecology. The Cities and Counties prepared a joint program description in 2008 that outlines their individual, semi-regional, and regional program activities.

## 6 Hydraulic Modeling

This chapter describes the hydraulic modeling that was completed to determine where system facility upgrades are needed. The modeling was completed to predict system upgrades based on the City's land use and zoning as identified in *Planning to Blossom 2025: Wenatchee Urban Area Comprehensive Plan* (2008).

The runoff hydrology and hydraulics for the planning area were completed using the SWMM (Storm Water Management Model, EPA) for single-event modeling and a combination of HSPF (Hydrological Simulation Program – Fortran, U.S. Geological Survey [USGS]) and SWMM for a continuous-event approach. This combination of HSPF and SWMM was configured to predict runoff in the transport mode. Using HSPF, historical rainfall data was applied to the study area to determine the resulting runoff responses. The responses were statistically sorted to determine various return period flows at each pipe in the system. Output information was sorted and tabulated for the 2-year, 10-year, and 25-year flow regimes.

Using the SWMM modeling process, routing alternatives were reviewed to determine the least-cost approach(es) to recommend for making system improvements. From this process, recommendations were made for piping upgrades, outfall improvements, and detention facilities. In addition, recommendations for the minimum level of service to be adopted by the City for its storm drain facilities were determined.

## 6.1 Storm Water Management Model (SWMM)

Wenatchee's stormwater collection system was computer modeled using the EPA-developed SWMM software. The model simulates the movement of precipitation and/or pollutants from the ground surface through pipe and channel networks and storage/treatment units and finally to receiving waters. Both single-event and continuous simulation can be performed. Continuous simulation was used in this Plan with input of precipitation records that were obtained from the Western Region Climate Center for storms before October 1993. Rainfall data after October 1993 was obtained from the WSU Tree Fruit Research Center on Western Avenue in Wenatchee. This precipitation data was applied to the study area using HSPF. Runoff responses from HSPF were converted into a SWMM interface file using the Western Washington Continuous Hydrology Simulation Model 3 (WWHM3). These interface files are read by SWMM instead of using the RUNOFF block from SWMM. This method generates a more accurate runoff response.

The SWMM program is constructed in the form of "blocks," with each block having a specific function. Blocks used to model the Wenatchee system were the runoff, transport, and rain blocks. Blocks not used were Extran, storage/treatment, temperature, graph, statistics, and combine. These additional blocks were not used for the modeling since these features were not necessary for this modeling.

#### Runoff Block

The runoff block receives meteorological data from either rain and/or temperature blocks or user-defined hyetographs and then simulates the rainfall-runoff process using a nonlinear reservoir approach, with an option for snowmelt simulation. The City's model was set up using only the runoff blocks for determining the runoff response for all single-

event model runs. In the historical precipitation time series, snowfall was modeled as rainfall precipitation because snow melt has not historically caused runoff problems. In this modeling, meteorological data was integrated by using actual historical precipitation records to generate the rainfall runoff response.

#### **Transport Block**

The transport block performs the detailed flow routing through the drainage system by means of the kinematic-wave method. The kinematic-wave method is a hydraulic method for routing runoff across planar surfaces and through small channels and pipes. A benefit of the transport block over the runoff block for modeling the piping network is its ability to perform a limited backwater analysis. The backwater analysis allows the system to be analyzed with pipes surcharged to street grade and allows the model to predict where surface flows will occur when subsurface piping is over capacity.

## 6.1.1 Original SWMM Modeling (1992)

In 1992, the base data input was compiled using information obtained from the City's storm sewer cards. This data was entered into the computer model. This was done as part of a storm drain study for the City, which was compiled by Forsgren Associates of East Wenatchee. Modeling for that project was also done with SWMM software, but the configuration was limited to just the runoff block mode, so the ability to consider some pipes with surcharging flows (that is, a backwater analysis) and combinations of surface and subsurface piped flows was not available.

Rainfall for Forsgren's work appears to have been inputted as an even distribution across the whole study area using 0.98 inch falling over a 1-hour period. Their report includes a duration – volume graph that shows 0.98 inch at the 1-hour mark, and a hyetograph (rainfall distribution) that shows a level distribution of the 0.98 inch over a 1-hour period. Flow routing processes, as a subsequent feature to rainfall application, are not documented.

It also appears that the Forsgren (1992) modeling was based on single-event simulation rather than continuous-event simulation.

The response to the rainfall application and flow routing that was used was outputted in 5-minute intervals to establish a number set of flows for critical conveyance piping, which, when graphed, would create a hydrograph for any pipe of interest. The peak flow for any given hydrograph was considered to be the 10-year storm flow.

## 6.1.2 SWMM Modeling (1998-1999)

In 1998 and 1999, Wenatchee's collection system was modeled by Hammond Collier working with subconsultant Joe Brascher of Aqua Terra Consultants of Everett, Washington, using SWMM software. Modeling used all rainfall records from the Wenatchee Tree Fruit Research Center Gauge Station as input, starting with 1948 and ending with 1996. The gauge station at the Wenatchee Tree Fruit Research Center is located in the center of the study area, has the longest history of rainfall recording, and was the only gauge station to have continuous 1-hour, not 12- or 24-hour, readings for this period. Its data was reviewed against other data from other local stations and was found to be most accurate for this project, so it was exclusively used.

The rainfall was applied to the study area as a continuous process, starting with the beginning precipitation record and ending with the last. Each record was applied evenly over a 1-hour period, since the records were only available in 1-hour increments.

The response to the continuous rainfall application from 1948 to 1996 was a successive set of flow information for each pipe or pipe set. Flow routing was done automatically by the computer as a facility of the backwater analysis. The flow output was then statistically analyzed to determine the 2-year, 5-year, 10-year, and 25-year points of probable exceedence for flows in each pipe.

## 6.1.3 SWMM Modeling (2009)

In 2009, Wenatchee's collection system was again modeled using SWMM software and WWHM3 software with modeling work completed by Clear Creek Solutions assisted by Erlandsen. Modeling again used all rainfall records from the Wenatchee Tree Fruit Research Center Gauge Station as input, starting with 1948 and ending with 2009. The original rainfall data was combined with new data obtained from the WSU AgWeatherNet website. This new data, starting in 1996, has a 15-minute interval as compared to the original 60-minute interval, which improves the accuracy of the model.

## 6.2 Continuous-Event Model Input

## 6.2.1 Overview - Continuous-Event versus Single-Event Simulation

Continuous-event modeling applies a significant number of rainfall events, one after another, to a drainage basin to produce runoff. It also measures the antecedent conditions that develop to determine their significance. Continuous-event modeling can also measure antecedent condition changes that develop from variables in the drainage network such as infiltration rates, surface storage, and drying conditions.

The antecedent flows that are produced for each pipe or drainage feature as a result of applying all rainfall events are subjected to a statistical analysis to determine the probability of exceedence. This ranks the antecedent conditions for each pipe and determines the break points for 2-year, 10-year, 25-year, and other return-period flows. Continuous-event modeling is considered the most accurate method of determining the runoff response.

For comparison purposes, single-event modeling applies only one storm event (a well-defined rainfall distribution) to a drainage network and measures the antecedent conditions for the single storm event. The option to vary infiltration rates, surface storage, and/or drying conditions is usually not used with this approach. Antecedent flows from the single storm are subjected to a probability analysis to determine the various return-period flows throughout the drainage system.

The continuous simulation runoff response modeling was performed using the WWHM3, with the WWHM3 using HSPF as its runoff generation engine. This is considered the most accurate continuous-modeling methodology.

#### 6.2.2 Study Area Input Data

#### **Sub-catchment Areas**

Section 3.1.1 describes the division of the urban drainage areas into 12 subbasins, or natural drainage areas within the study area. It also describes the three canyon basin drainage areas (no subbasins were assigned in the canyon areas). Exhibit 3.1-2 shows the numbering used for each subbasin area (for example, M-2, M-40, M-70, etc.) and the canyon basins. Subbasin boundaries were developed in the urban area based on connecting all drainage areas that would flow to a major outfall.

Sub-catchment delineations are further divisions in the study area of sub-basins into smaller areas for the purpose of entering this into the SWMM model. Data entry for sub-catchments included slopes, land-use characteristics, soils, and area. The data for each sub-catchment area was inputted so that flows would be generated at a node in the drainage system. Nodes are best described as intersection points of two pipes (usually a manhole) or an interim drainage point along a ditch. The full delineation of subbasins and sub-catchments used in this study is shown on Exhibit 3.1-2. Data entry for modeling was made at the node at the downstream edge of each sub-catchment.

#### **Topographic Slopes**

Surface slope information for the existing study area consisted was obtained by calculating the average slope across each sub-catchment area. The surface slopes used for input data were determined using the sub-catchment map (see Exhibit 2.5-1 and Exhibit 3.1-2).

#### **Land Use**

The land-use/zoning pattern within the UGA, shown on Exhibit 2.3-1, was obtained from the City's Community Development Department. The zoning represents the City's growth projections to the year 2025.

In order to project accurate runoff, the zoning was further modified in the hydraulic model to breakout parks and playfields as independent elements separate from the zoning. In addition, due to discharge limitations presented in Section 6.6, land use in several areas in north Wenatchee was modified to reflect existing conditions where future development would be required to have detention. These facilities will be required to maintain predevelopment discharge rates. For the purpose of modeling, these areas were assumed to be in the Rural Suburban category.

#### **Effective Impervious Surface Factors**

Effective impervious surface factors were assigned to every sub-catchment for the land-use zoning. Table 6.2-1 shows the relationship between the zoning classifications for the existing conditions and the effective impervious surface factors that were assigned. The effective impervious surface factors, as used in this study, produce different results than unadjusted impervious factors. The unadjusted factor is considered to be the total impervious surface area taken as a percentage of the gross size of a building lot. The effective impervious surface factor considers on-site infiltration and detention storage, and it is usually a smaller percentage than the comparable unadjusted factor. The effective impervious surface factors are less conservative and more closely replicate actual conditions. Therefore, they were used in the runoff modeling for this study. The percentages shown in Table 6.2-1 have been extensively used in various applications throughout the Pacific Northwest and have been validated.

<b>Table 6.2-1</b>		
Land-Use and Effective Percent Impervious Values Used for		
Hydrologic Modeling		
	Effective Impervious <sup>1</sup>	
Land-Use Category	Surface	
Rural Suburban (RS)	10%	
Mixed Residential (RS & R1)	26%	
Low-Density Residential (R1)	26%	
Multi-Family Residential (R2)	26%	
High-Density Residential (R3)	48%	
Mixed High-Density Residential	48%	
Commercial/Commercial Business District	86%	
Neighborhood Commercial	86%	
Industrial	86%	
Green Space	0–5% <sup>2</sup>	
Park	0–5% <sup>2</sup>	
Open Space	0–5% <sup>2</sup>	

- 1. Adjusted/assumed effective impervious surface percentages. (See discussion in following paragraph.)
- 2. The assigned percentage assumes that a layer of top soil exists and that its water infiltration capacity is up to 1 inch for the first hour (clay/loam soil). An assumption is also made that a significant storm (resulting from thunderstorms) falling on normally dry soils will produce some runoff when the precipitation rate exceeds the infiltration rate.

#### **Composite Runoff Factors**

For all single-event models, the SWMM RUNOFF module was used to generate surface runoff, and composite runoff factors were calculated and entered into the SWMM modeling program. These composite runoff factors were comprised of all of the following: (1) slope, (2) soil type, (3) area, and (4) effective impervious surface factor (based on land use).

For the continuous modeling, the land-use data was entered as it was generated from Table 6.2-1 above.

## 6.2.3 Collection/Drainage System Input

#### **Pipe Numbers**

Pipe numbers were assigned to pipes in each subbasin in order to establish modeling parameters. Many of the smaller collector pipes in these subbasins were combined and labeled as one longer pipe with equivalent hydraulic properties. Due to system upgrades and additions, pipe numbers were revised from previous modeling in order to add these additional pipes into the system. The SWMM hydraulic model was set up with all outputs tied to pipe numbers.

#### Pipe *n* Values

Manning's n values, or pipe roughness coefficients, were chosen based on information in the 1992 Ecology Puget Sound Stormwater Manual. In order to correctly model backwater flow, input for this study used more-conservative values. The backwater n

values are about 15% higher than unadjusted n values for uniform flow. The use of backwater flow n values allows incorporation of the minor head losses associated with entrance, exit, and junctions.

Table 6.2-2 lists the backwater flow n values that were assigned to the different pipe materials in the city system. A companion column shows n values for pipe materials independent of minor head loss considerations based on uniform flow.

Table 6.2-2 Manning's <i>n</i> Values				
	Backwater n	Uniform Flow n		
Pipe Material	Value	Value		
Concrete Pipe	0.014	0.012		
Corrugated-Smooth Interior Polyethylene	0.014	0.012		
Pipe (CPEP)				
Corrugated Metal Pipe (CMP)	0.028	0.024		
Spiral Rib Metal Pipe	0.013	0.011		
PVC Pipe	0.013	0.011		
Ductile Iron Pipe-Cement Lined	0.014	0.012		
High-Density Polyethylene Pipe (HDPE) <sup>1</sup>	0.009	0.008		
Cured-in-Place Liner (InsituForm or Equal)	0.010	0.009		
ADS Pipe	0.014	0.012		
Dipped Steel <sup>2</sup>	0.014	0.012		

<sup>1.</sup> Butt fused only.

#### Nodes

Nodes are technically defined as the intersection of two or more pipes. Specific model outputs at the nodes were not generated under this study since the City determined that node information was not of interest for this report.

#### 6.2.4 Rainfall (Precipitation) Input

Three approaches are often reviewed for assigning rainfall distribution in SWMM modeling. They are listed below in the order of preference for use.

- 1. 15-minute gauge station readings
- 2. 1-hour gauge station readings
- 3. 15-minute synthetic readings from hyetographs

In this study, a combination of 15-minute and 1-hour gauge station readings was used for the model based on information available from the AgWeatherNet website for the WSU Tree Fruit Research Weather Station. The 15-minute synthetic readings were used in SWMM. The 15-minute and hourly data was used with WWHM3.

Data from the rainfall gauge station records was reviewed to determine recurrent storm magnitudes for the study area. Rainfall data from July 1948 to January 2009 was used in the hydraulic model.

<sup>2.</sup> Dipped steel pipes were assumed to be CMP with an interior and exterior coating of spun asphalt that fills the corrugations.

## One-Hour Depth(s) by Historical Records

Table 6.2-3 shows the equivalent 1-hour depths for various return periods of interest as determined from historical precipitation records.

Table 6.2-3 One-Hour Depths for Return-Period Storms Using Historical Rainfall Records			
One-Hour Depth (inches)	Return Period (years)	Exceedance Probability	
0.20	1.005	0.995	
0.21	1.010	0.990	
0.24	1.053	0.950	
0.26	1.111	0.900	
0.29	1.250	0.800	
0.39	2.000	0.500	
0.56	5.000	0.200	
0.70	10.000	0.100	
0.92	25.000	0.040	
1.11	50.000	0.020	
1.33	100.000	0.010	
1.58	200.000	0.005	
1.98	500.000	0.002	

Note: Statistically developed from gauge records from WSU Tree Fruit Research Center, Wenatchee

## **Comparison of Historical Rainfall Depths to Synthesized Depths**

Synthetic design storms are derived by synthesis and generalization of a large number of actual storms from similar areas. It is always appropriate to compare the variables of the proposed design storm to similar variables from other methods that might be in use in the local area.

Table 6.2-4 compares synthetic 1-hour rainfall depth results to depths that were derived using actual records.

Table 6.2-4				
One-Hour Rainfall Depth (inches) for Various Return Periods –				
	Historic v	ersus Synthet	ic Projects	
	Α	В	С	D
Return Period	Douglas County/ East Wen. Stormwater Utility <sup>1</sup>	1999 WSDOT Highway Runoff Manual <sup>2</sup>	Historical Rainfall for City of Wenatchee <sup>3</sup>	Synthetic Estimate Based on 24 Hour Storm <sup>4</sup> Depth = 2.04"
6 months <sup>5</sup>	0.40	0.46	0.25	0.34
2 years	0.61	0.71	0.39	0.52
5 years	0.82	0.89	0.56	0.70
10 years	1.00	1.03	0.70	0.85
25 years	1.13	1.18	0.92	0.96
50 years	1.33	1.32	1.11	1.13
100 years	1.44	1.46	1.33	1.22

#### Notes:

- 1. Based on Douglas County utility management's directives to use 2.0 inches/90 minutes, 2.4 inches/24 hours, and a modified Soil Conservation Service (SCS) Type II Rainfall Distribution.
- 2. Based on National Oceanic and Atmospheric Administration (NOAA) Isopluvials for Washington State and SCS Type II Storm Distribution. Estimated 24-hour storm intensity = 3.9 inches/hour, which exceeds most 100-year Isopluvials.
- 3. From hourly rainfall records at WSU Tree Fruit Station.
- 4. Assumes 24-hour depth of 2.04 inches = 25-year storm event and 2.60 inches = 100-year storm event (from Northwest Hydraulics 1996), SCS Type IA Storm Distribution, and proportional relationship from NOAA Isopluvials for the 24-hour storm event.
- 5. Assumed at 65% of 2-year depth.

A further comparison between the critical storm event (December 3, 2007) and the various synthetic rainfall curves was completed as part of the study. The critical storm event is defined as the single event that yielded the largest surcharges that occurred during the period when the available data was collected. The regional, SCS Type II, and SCS Type IA storms as developed in the Stormwater Management Manual for Eastern Washington were compared to historical data. As stated in the manual, the regional storm distribution is based on general storms that occur in Eastern Washington and is characterized by lower rainfall intensities and larger volumes compared to a short-duration storm (or thunderstorm). Exhibits 6.2-1 through 6.2-3 compare the critical storm and the synthetic events. Based on this comparison, the SCS Type IA storm most closely matched the historical data.

Exhibit 6.2-1 Historical versus Regional Storm Curves December 3, 2007

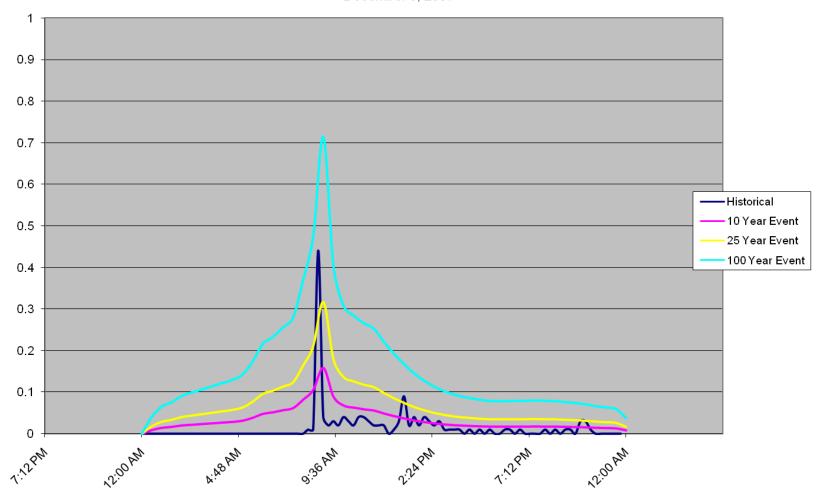


Exhibit 6.2-2 Historical versus Type IA Curve December 3, 2007

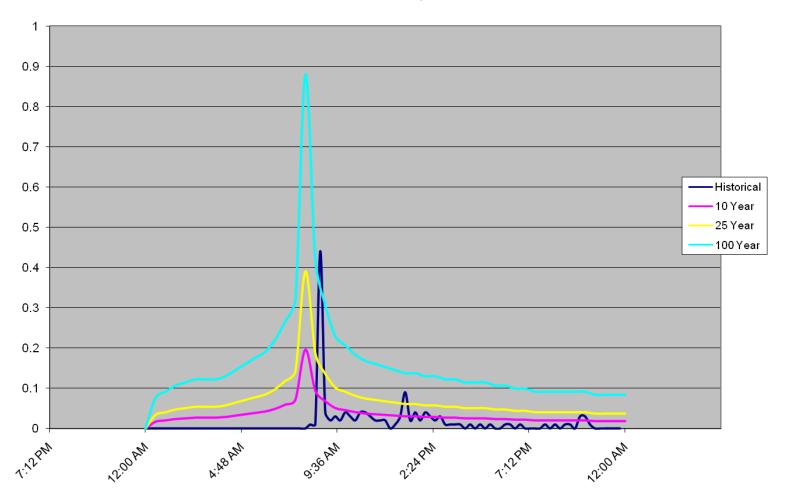
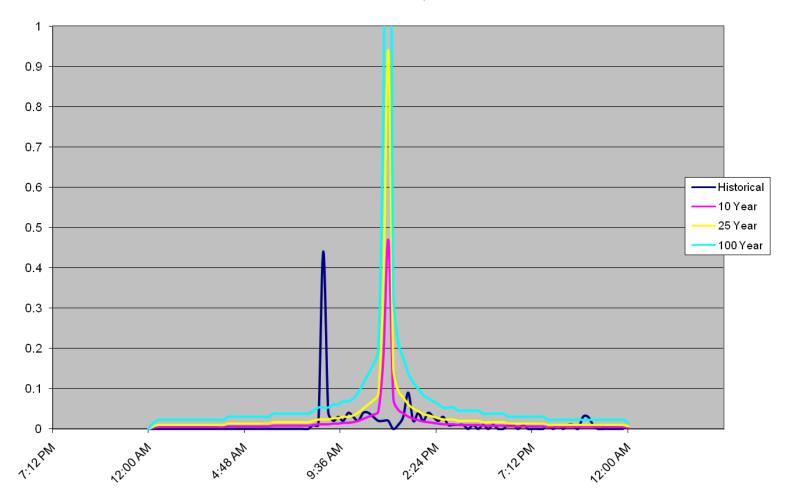


Exhibit 6.2-3 Historical versus Type II Curve December 3, 2007



#### 6.2.5 Flow Routing

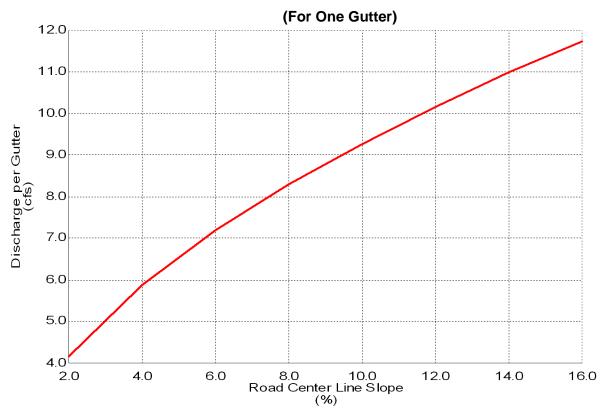
Flow routing was completed by computer based on internal backwater calculations.

Output data indicates surface water flow when flow estimates exceed pipe capacities for the return period of interest. Where surface water flows were anticipated as a conclusion of the analysis, city street sections were reviewed to determine whether there were curbs to keep flows in the street section. In some locations where curbs are missing, street upgrades including curb, gutter, and sidewalks are planned in the 6-year capital street improvement plan. In most other areas where curbs are missing, there are no surface flows in roadside ditches. Based on these findings, flow routing by the computer was accepted and used throughout the city's urban drainage area. Exhibit 6.2-4 shows the relationship between the road center line slope and discharge per gutter.

Exhibit 6.2-4

Maximum Surface – Gutter Flows

Roadway Centerline Slope versus Discharge



Note: Based on graph: (1) Assigned 4.0 cubic feet per second (cfs) maximum per gutter for design purposes, and (2) Flow depth at gutter = 0.3 foot to 0.35 foot with two slopes between 0.5 and 1.0%, and 4.0 cfs flow.

Based on maintaining gutter flows at less than 0.25 foot in depth, with 3% cross slope on roadway to ensure reasonable flow control after convergence of side streets and on minimum slope streets (greater than or equal to 2%).

Exhibit 6.2-4 was developed to quantify maximum safe gutter flows when surface water flows are anticipated as a result of surcharging pipes. It can also be used to predict safe gutter flows where catch basins are missing; that is, where there are long distances between catch basins. In general, an effort was made to keep gutter flows from exceeding 8.0 cfs total on any street (4 cfs for any gutter).

## 6.3 Modeling Outputs

SWMM modeling output has been electronically sorted and prepared in tabular form. The data is available for review in Appendix E. The data is catalogued under the title Computer Modeling Results, Urban Conveyance System Analysis Current Conditions.

## 6.3.1 Explanation of Tabulated Modeling Results

The design flow spreadsheets in Appendix E include tabulated results for current conditions and an explanation of tabulated information. Note that tabulated information is presented to describe one of two scenarios:

- 1. Flows in an open ditch where no piping exists. In this situation, ditch reaches have been designated using pipe numbers.
- 2. Flows that have been routed automatically in existing storm drain pipes by the computer down city streets. In this case, the information that is presented is shown opposite a pipe number to give the reader a point of reference between the expanded system exhibit provided in the back of the Plan and the modeling results.

Tabulated information includes:

- Culvert Number The number or identification of an individual pipe or run.
- Culvert Slope Slope of each pipe or ditch.
- Culvert Length Length of each pipe or ditch.
- Manning's Value Refer to Table 6.2-2.
- Culvert Size Diameter of the pipe in feet. (No size was shown for ditches.)
- Culvert Capacity The maximum flow the pipe will convey under non-head-driven conditions, based on slope, n value, diameter, and length of pipe. Results are provided as a rate of flow in cfs.
- Maximum Flow The maximum flow the pipe will convey under head-driven conditions (backwater surcharge). The result is based on the culvert capacity with the hydraulic grade line approximately at the top of inlet grates based on a typical bury depth of 3 feet (that is, at the street grade).
- Existing Conditions Modeling Results Runoff calculations for various return-period flow frequencies at locations along the existing pipe system based on build-out of existing zoning designations within the existing urban growth boundary. Some culverts are known to surcharge. Information in the tables has been sorted to show flows for the 2-year, 10-year, and 25-year storm events in cfs.

- Future Conditions Modeling Results Runoff calculations for various return-period flow frequencies at locations along the existing pipe system based on build-out of existing zoning designations within the existing urban growth boundary. These calculations are based upon upgrade pipe sizes. Some culverts are known to surcharge. Information in the tables has been sorted to show flows for the 2-year, 10year, and 25-year storm events in cfs.
- Design Flows Design targets for various return periods, including the 10-year and the 25-year design event. Where existing culvert capacity or culvert maximum flow (head-driven) does not exceed or equal the maximum modeled flows, no upgrades are proposed (this takes into consideration modest street flows).

## 6.3.2 Availability of Hydrographs

Hydrographs are available as an output from all SWMM modeling that was done for this study. They can be produced for the 2-year, 10-year, and 25-year flow regimes. Extrapolations can also easily be made to predict the 6-month flow regime.

## 6.4 Analysis of Model Results to Determine Deficient Pipes

The storm drainage system was analyzed on a pipe-by-pipe basis. The initial review of the model output data was based on the future urban growth boundary and the 10-year storm event. The maximum head-driven flow in each pipe was compared to the Future Conditions Frequency flow rates for the 10-Year return period. If flows in the Future Conditions Frequency were less than those in the head-driven column, then the pipe was considered sufficient for a given storm. If the pipe flows were in excess of 8 cfs over the maximum head-driven flow (allowance for surface flow), then the pipe was considered deficient. Surcharge times were also reviewed to determine the length of surcharge and the impacts to the surrounding area.

The 8-cfs overage in flows (4 cfs per gutter) was considered to be a reasonable surface flow for each street and was used as a guide for the maximum gutter conveyance flow rate (see Section 6.2.5).

The results of the hydraulic modeling indicate limited problems in the conveyance system based on the current system configuration. Table 6.4-1 lists those system deficiencies based on the modeling. Additional areas that lack collection systems have also been identified as areas in need of system extensions.

	Table 6.4-1 Collection System Improvement Areas				
Project Code <sup>1</sup>	Street	Cross Street	Cross Street	Problem	
C1	Miller	North of Maple		Insufficient Capacity	
C2	North Wenatchee Ave.	North of Maiden Lane		Lack of Collection	
C3	Western Ave.	No. 2 Canyon	Orchard	Conveyance	
C4	Pershing	Springwater	Maple	Conveyance	
E1	Walnut	Wenatchee Ave	Western	Lack of Collection	
E2	McKittrick	Wenatchee Ave	Western	Lack of Collection	
C5	Filbeck			Lack of Collection	
C6	Seattle			Lack of Collection	

	Table 6.4-1 Collection System Improvement Areas				
Project Code <sup>1</sup>	Street	Cross Street	Cross Street	Problem	
C7	Tacoma and Pine			Lack of Collection	
C8	Ramona and Sunset			Lack of Collection	
C9	Orchard	Western	Marie	Lack of Collection	
C10	Kenaston and Linville	Western	Castlerock Hts	Lack of Collection	
C11	Marr and Marjo	Mission	Wenatchee Ave	Lack of Collection	
C12	South Wenatchee Ave.	Crawford	Viewdale	Lack of Collection	
C13	Skyline Drive			Lack of Collection	
E3	Maple Street	West of Benoit		Lack of Collection	
E4	Springwater	West of Western		Lack of Collection	
C14	Horse Lake Road			Lack of Collection	
C15	Poplar	Springwater	Westwood	Lack of Collection	
E5	South Hills Drive			Lack of Collection	
E6	Avenida			Lack of Collection	
C16	Methow	Crawford	Ridgeview Loop	Lack of Collection	
E7	Squilchuck Highway	Terminal		Lack of Collection	
E8	Jennings Street			Lack of Collection	
C17	Day Road			Lack of Collection	
E9	Ione and Maxine	West of Orchard		Lack of Collection	

<sup>1.</sup> Project Codes use a "C" for Conveyance Improvements that are deficient within the city's existing infrastructure and an "E" for system extensions to new service areas.

## 6.5 Selection of Level of Service for Upgrading Facilities and Meeting Concurrency

The Transportation Element of the Growth Management Act recommends that the City adopt a level of service for developing and maintaining its facilities. For the stormwater system, this includes assigning the level of runoff control (from a designated returnperiod storm) that will be maintained for city residents as improvements are made. The city's existing stormwater system has been designed for a 10-year event. Maintaining this criterion is essential for preserving infrastructure and level of service.

## 6.5.1 Minimum Level of Service

In the analysis of alternatives for upgrading the city's storm drain system, both the 10-year and 25-year continuous simulation runoff scenarios were initially considered to establish cost comparisons for future decision-making purposes. Based on discussions with the City, Erlandsen ultimately decided that the minimum level of service would be best represented by the 10-year storm event modeled with the Type IA Hyetograph for new developments. Based on a comparison between historical data and synthetic events, the best fit was again the 10-year Type IA event. Main trunk line expansions will need to be sized based on actual hydraulic modeling using the historical data.

## 6.5.2 Synthetic Alternate to SWMM Modeling (Local Use Applications)

After reviewing Table 6.2-4, Erlandsen concluded that the use of any information other than historical rainfall records for this study would produce conservative results (that is, higher flows due to higher rainfall depths). This comparison adds supports to the decision to use actual data to derive actual storm runoff for this study.

Further review suggests that there is a close correlation between Column C and Column D in Table 6.2-4. Column C is historical rainfall depths, and Column D is based on a 25-year storm with depth fixed at 2.04 inches in 24 hours. For the 10- and 25-year events, data in the two columns is similar, although use of the synthetic method would produce somewhat higher flows. The relationship between historic and synthetic SCS Type IA rainfall distribution with assignment of 24-hour, 25-year depth of 2.04 inches is close enough to allow this specific synthetic approach to be used as an alternate for determining local runoff for situations in which updating the SWMM model is impractical.

Using the same assignment of 2.04 inches for the 24-hour, 25-year storm and proportioning against NOAA Isopluvials, 24-hour synthetic depths for other return periods (for use with the SCS runoff method and Type IA storm distribution) have been determined and are included in Table 6.5-1.

Table 6.5-1 Custom 24-Hour Rainfall Depths for Use with SCS Type IA Storm Distribution		
24-Hour Depths		
Return Period	(inches)	
2 years	1.10	
5 years	1.50	
10 years	1.80	
25 years	2.04	
50 years	2.40	
100 years	2.60	

Note: Determined from custom Isopluvials developed using recorded maximum of 2.04 inches (1972 to 1996) and proportioned using NOAA Isopluvials.

## 6.5.3 Concurrency under the Growth Management Act (GMA)

All alternative upgrades to the city's storm drainage system were considered in light of bringing the city to the minimum level of service (protection for the 10-year storm runoff) which, when fully implemented, would address the concurrency issue (that is, the city would be concurrent with the level of service established under the GMA).

#### 6.6 Evaluation of Alternatives

Several alternatives were reviewed once the continuous-event computer model was established. These alternatives are discussed in this section.

## 6.6.1 Upland Detention Facilities

This system evaluation considered establishing upslope detention facilities in lieu of making pipe improvements in the center of the city's service area. After the modeling, Erlandsen determined that the city's collection system has the capacity to convey the 10-year design storm to the Columbia River. Future development in North Wenatchee will require maintaining established discharge rates, which will require additional detention. How much detention and where it will be located will be based on development patterns. Exhibit 6.6-1 shows the areas where on site detention would be required.

## 6.6.2 Piping Alternatives

Piping alternatives for conveying emerging flows from new development areas in the city were also considered. The major corridors that were reviewed are shown on Exhibit 6.6-2.

#### 6.6.3 Determination of Outfall Capacities and Deficiencies

The maximum capacities of all the city stormwater outfalls were established early during the modeling. The study assumed that permits associated with establishing any new outfalls would be difficult to obtain because of emerging water quality issues. The study also assumed that upstream or end-of-pipe treatment would be required for any newly proposed outfalls. Therefore, an attempt was made to maximize all outfalls during modeling. Table 6.6-1 at the end of this chapter lists urban system outfalls and their capacities. Exhibit 6.6-3 accompanies Table 6.6-1 and shows the north Wenatchee stormwater system.

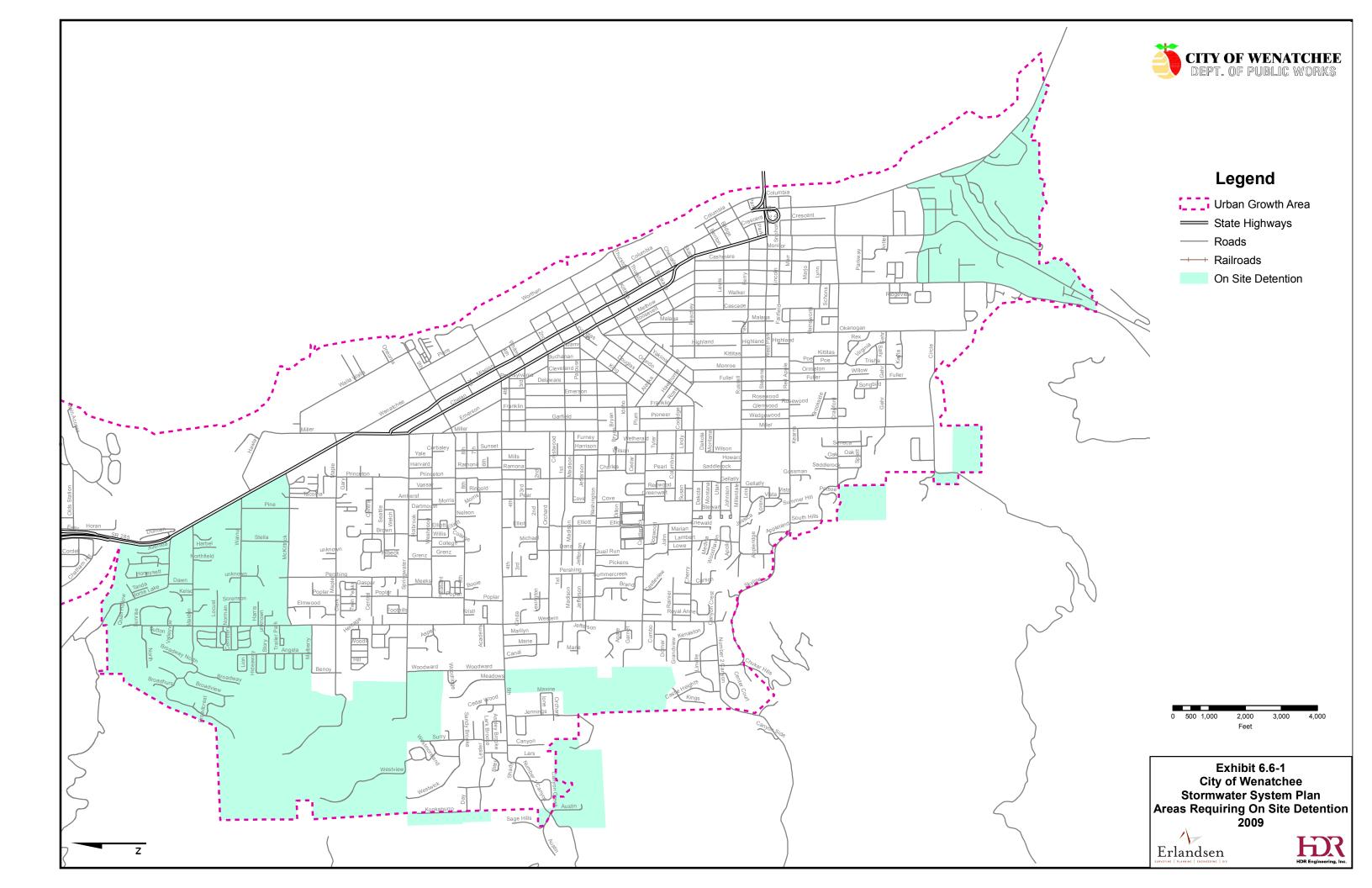
## 6.7 Identification of Local Drainage Problems

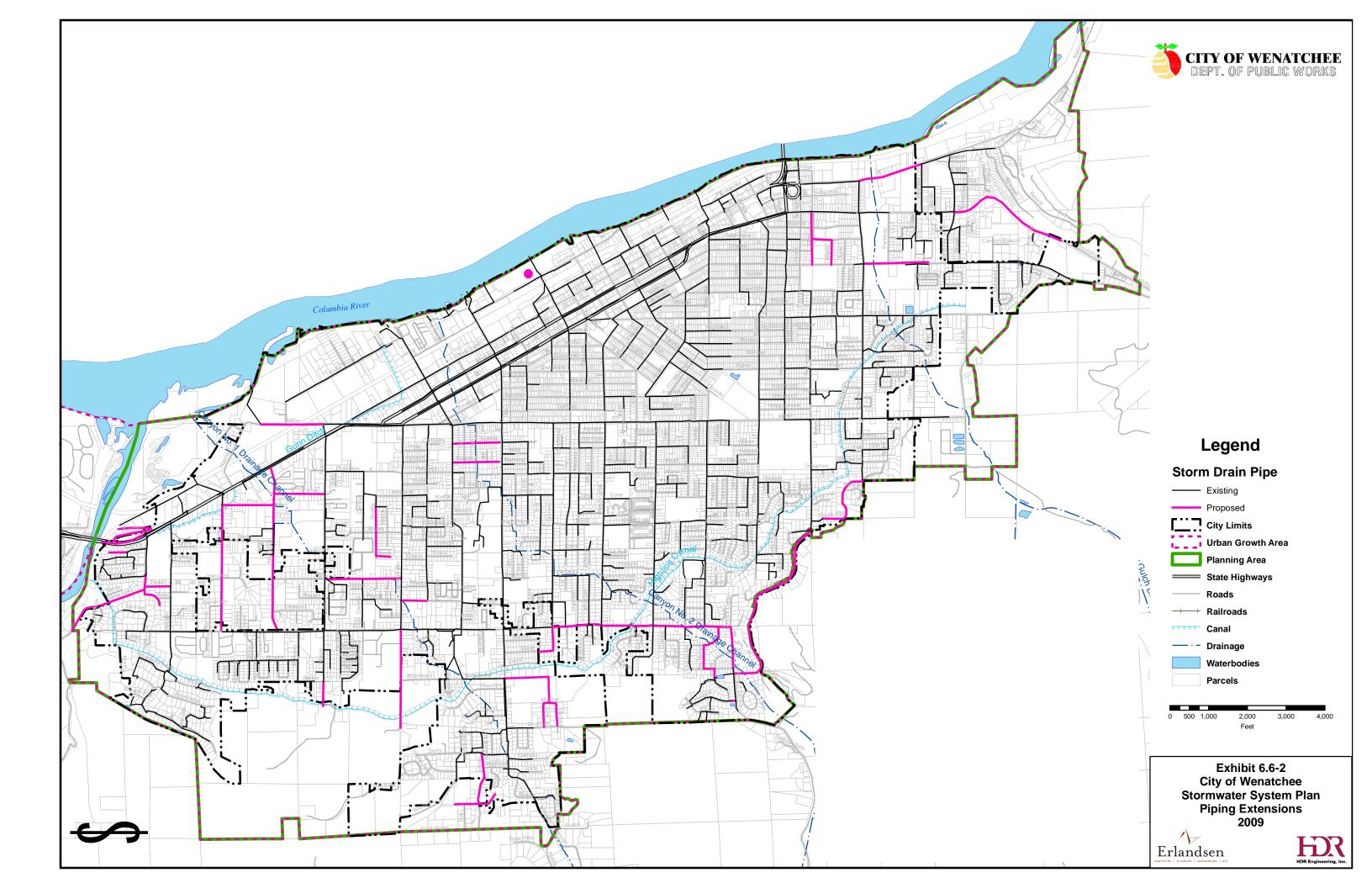
Several local drainage problems were identified during field reconnaissance conducted for this plan (see Table 6.7-1 and Exhibit 6.7-1). Repairs and collection system improvements were included in the development of the capital improvement plan. For these smaller projects, \$100,000 per year was budgeted. A specific description of each problem is included in Chapter 9.

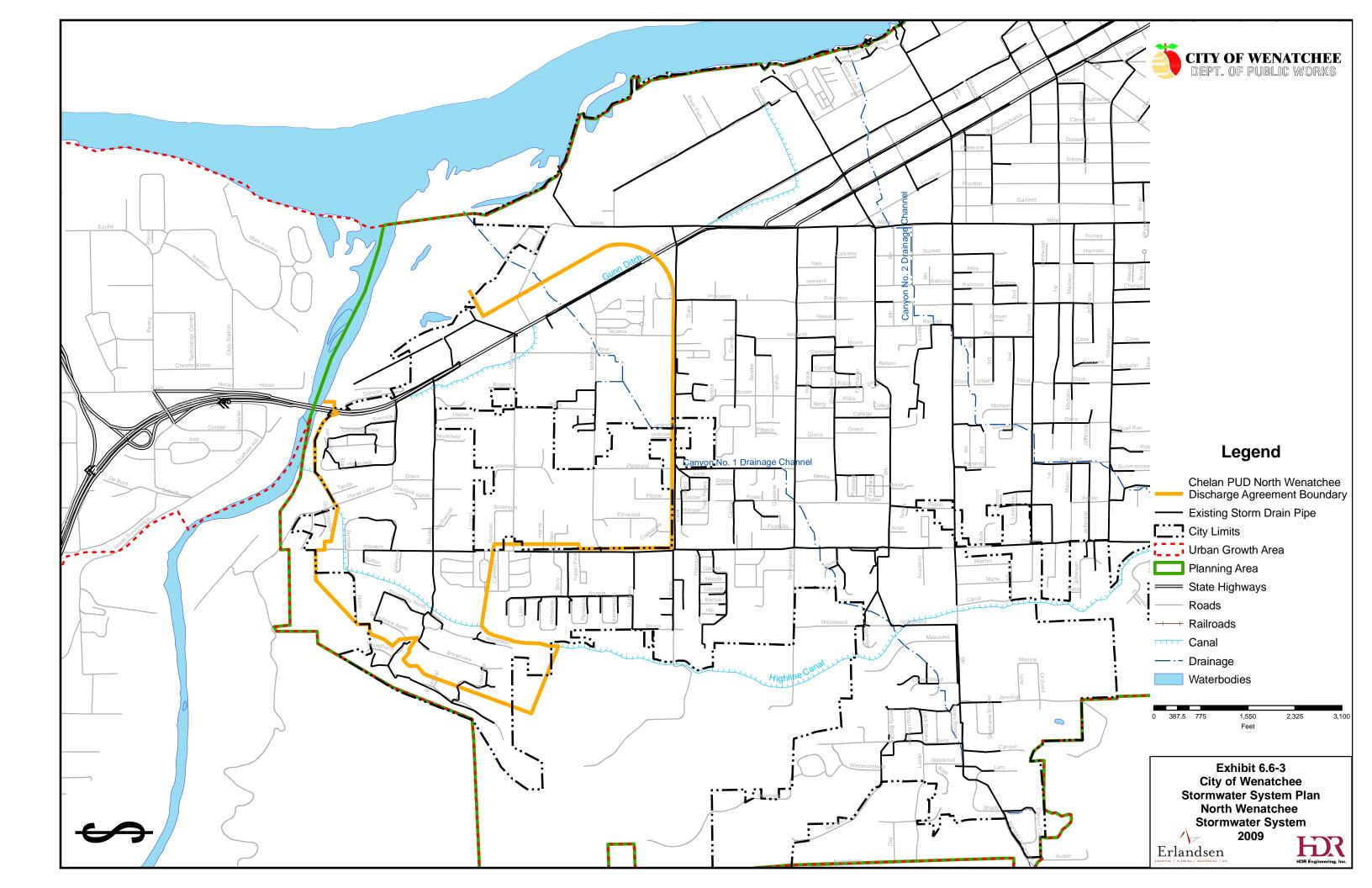
Table 6.7-1 Collection System Problem Areas			
Street Problem			
Walla Walla	Broken Lateral		
Peachey and S. Mission	Inlet Capacity		
Spokane and S. Chelan	Inlet Capacity		
Ferry and S. Mission	Inlet Capacity		
Overlook Drive	Nuisance Flooding		
Lowe Street	Nuisance Flooding		
Orchard and Miller	Inlet Capacity		

## 6.8 Conclusions for the Wenatchee Urban System

Based on historical precipitation data, the SCS Type IA storm was found to most closely follow the intensity and duration of storms seen in Wenatchee. Analysis and computer modeling for the urban area showed only limited problems in the conveyance system. Upland detention facilities were recommended for future development in North Wenatchee. Piping alternatives and outfall capacities were also reviewed.







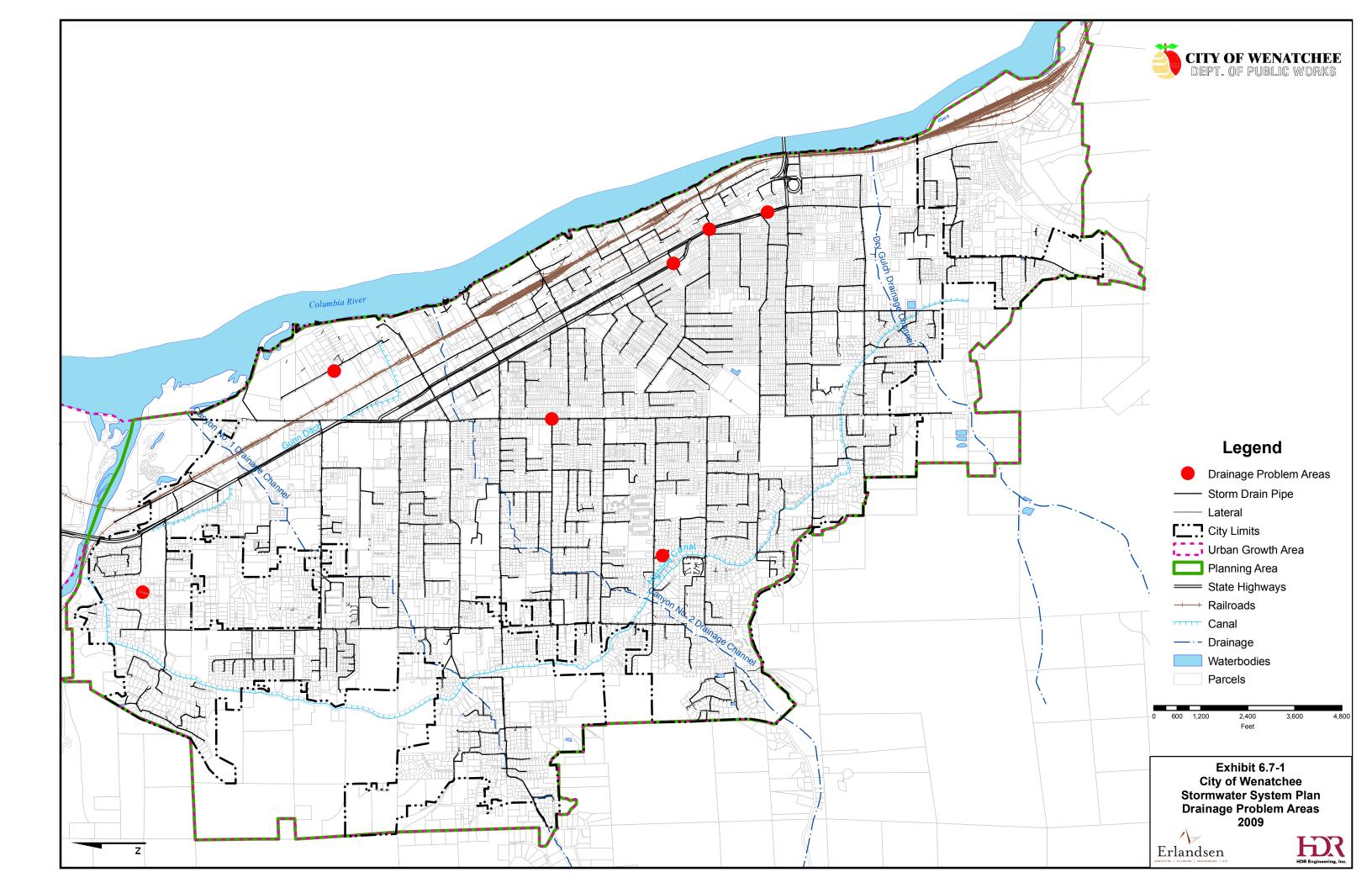


Table 6.6-1 Analysis of Urban System Outfall Flows and Capacities Conditions (2-year, 10-year, and 25-year Storm Events)								
		Future Flows Required under Surcharged to Street Grade Conditions (cfs)			Max. Head-Driven	Max. Outfall Head		
Location	Size (in)	2-Year	10-Year	25-Year	Capacity (cfs)	Velocity (ft/sec)		
Culvert under railroad at convergence of rail lines near Wenatchee River (local drainage only)	36	≤ 40	≤ 40	≤ 40	40	≤ 5.7		
900' northeast of East Walnut St. outfall (box culvert)	72	17	28.7	34.6	1750	1.2		
1,000' east of Hawley St./Miller St. intersection (pipe outfall) to ditch (Maple/Miller outfall) <sup>1</sup>	48	54.3	125.8	175.8	193	15.4		
600' northeast of Ninth St. (pipe outfall) to ditch and wetlands (Linden Tree Outfall)	42	76.9	92.6	97.8	101	10.5		
East Fifth St. (pipe outfall under water) <sup>2</sup>	48	109.7	207.1	300.0	229.7	18.3 (10-year) 23.9 (25-year)		
600' south of east Fifth St. (pipe outfall under water – local drainage only)	24	≤ 16	≤ 16	≤ 16	16	5.1		
East First St. (pipe outfall under water) <sup>3</sup>	36	27.6	64.8	91.4	31.0	4.4		
East Yakima St. (pipe outfall under water)	18	4.5	8.5	11.0	11.0	6.2		
East Thurston St. (pipe outfall under water)	36	12.7	29.9	42.2	≤ 80	6.0		
East Chehalis St. (pipe outfall exposed on the bank)	12	≤ 3	≤ 3	≤ 3	3.0	3.8		
Midway between Chehalis and Benton St. (pipe outfall under water)	54	89.5	173.1	221.6	220	13.8		
East Stevens St. outfall just north of Columbia River Bridge (pipe outfall under water)	30	2.5	5.8	8.1	≤ 80	1.1		
East Snohomish St. outfall just south of Columbia River Bridge (pipe outfall under water)	21	10.1	23.0	32.0	64	13.3		
Lincoln Park – Dry Gulch Outfall (pipe outfall under water)	48	37.7	75.9	98.3	127.0			
Squilchuck Creek (Appleyard) (pipe outfall under water)	48	22.1	55.0	79.8	152.0 <sup>4</sup>			

Improvements required starting about 970 feet upslope of outfall.
 Assumes lining of upstream pipe to convey 300 cfs because of potential risk to high-value real estate at foot of Fifth Street.
 Used future flows for Pipe No. 346 plus a contribution for local flows in this area to determine projections. Information on Pipe No. 392 (actual outfall pipe) is unknown.
 City Municipal Code requires that the Dry Gulch Canyon Drain has capacity to carry 150 cfs. Outfall capacity meets this requirement.

# 7 Flood Hazard Review and Proposed Action

# 7.1 Introduction

This chapter presents an overview of the recent flood hazard studies associated with Canyons No. 1 and 2 and Dry Gulch and discusses proposed alternatives and potential next steps for pursuing additional studies, design, and construction through U.S. Army Corps of Engineers (Corps) funding program opportunities and other opportunities.

# 7.2 Watershed Description

Canyons No. 1 and 2 and Dry Gulch are located immediately west of Wenatchee. These basins are situated along the east slopes of the Cascade Mountain foothills on the western edge of the semi-arid desert. Exhibit 7.2-1 shows the basin areas and the location of Canyons No. 1 and 2 and Dry Gulch.

Canyon No. 1 (the farthest north) has a basin area of about 6.8 square miles. Canyon No. 2 has a basin area of about 9.5 square miles. Dry Gulch (the farthest south) has a total basin area of about 4.0 square miles; about 2.4 square miles is largely controlled by an old mine tailings dam, while the remaining 1.6 square miles is uncontrolled (Northwest Hydraulics 1996).

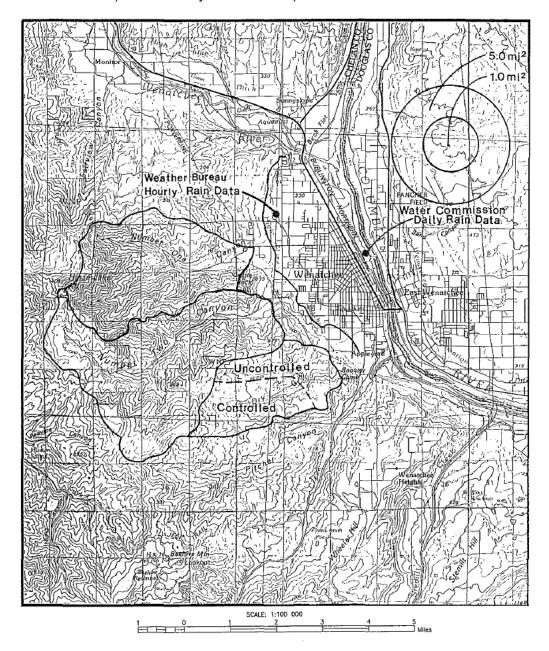
The basins are generally undeveloped outside the city limits, and impacts during storms extend into the city. Sagebrush and native grasses are the dominant native vegetation lower in the basin, with dense stands of Ponderosa pine and Douglas fir in the headwaters. Mean annual precipitation in the lower basin is about 15 inches, while the upper basin falls in the 20- to 25-inch precipitation zone. Based on soil types in the watershed, the runoff potential is relatively low (Type "B" Cashmere and Cashmont Sandy Loams/Gravelly Sandy Loam).

#### 7.3 Past Flood Hazard Studies

Over the last 35 years, several studies have been conducted to evaluate and propose flood hazard mitigation options and to outline future actions. The studies discussed both structural and non-structural BMPs to reduce flood hazards, erosion, and sedimentation and to improve water quality. The following list identifies these studies.

- Corps Study (1974)
- Chelan County Public Works Study (1977)
- Munson Engineers Wenatchee Area Flood Hazard Report (1980)
- Northwest Hydraulics Flood Hazard Investigation of Alluvial Fans below Canyon No. 1, Canyon No. 2, and Dry Gulch (1996)
- Hammond Collier Wade Livingstone Stormwater Management Plan for City of Wenatchee (2000)

Exhibit 7.2-1 Watershed Boundaries of Canyons No. 1 and 2 and Dry Gulch (Northwest Hydraulics 1996)



Hydrologic studies of the basin have shown the difficulty with estimating peak discharge rates for the small catchments in the planning area due to limited data and variability between accepted methods. Table 7.3-1, which is adapted from Hammond Collier Wade Livingston (2000), presents estimated flows in cfs for a range of flood frequencies for the three basins.

Table 7.3-1 Summary of Estimated Peak Discharge Estimates by Basin and Study Source (in cfs)								
Event	Corps	Munson Engineers	Northwest Hydraulics	Hammond Collier Wade Livingstone				
Canyon No.	•		<u> </u>					
2-year	120		20	75				
10-year	510		130	205				
25-year	860		380	300				
50-year	1,220		920	385				
100-year	1,680	980	1,150	485				
200-year	2,200							
Canyon No. 2	2							
2-year	130		25	100				
10-year	580		160	270				
25-year	1,000		500	395				
50-year	1,430		1,030	505				
100-year	1,980	900	1,200	635				
200-year	2,600							
Dry Gulch	Dry Gulch							
2-year								
10-year								
25-year								
50-year								
100-year		560						
200-year								

Note: Assumes that flows do not include sediment transport.

In addition to these studies, the Federal Emergency Management Agency (FEMA) has prepared a Flood Insurance Study (FIS), as well as several updates to the initial study, for the City. The most recent FIS is dated January 6, 1994, and the Flood Insurance Rate Map (FIRM), Panel No. 530020 005C, shows the areas of the 100-year and 500-year floodplains.

The City of Wenatchee is a participating community in the National Flood Insurance Program (NFIP), which means that the community is eligible for flood damage assistance and property owners are able to obtain flood insurance through the NFIP. In order to be participating community in the NFIP, the City of Wenatchee was required by FEMA to adopt a floodplain-management ordinance that conforms to the requirements of 44 CFR Parts 60 to 65. This means that minimum federal standards must be met for all encroachments into the floodplains shown on the FEMA FIRMs. This also means that the peak discharge values that are used as a basis for those FIRMs must be used as minimum regulatory values for floodplain-management purposes. The community is encouraged to use more restrictive floodplain-management criteria but must meet the minimum federal standards.

A FEMA Letter of Map Revision (LOMR) and accompanying revised floodplain delineation to the city dated May 13, 1996, revises the mapped floodplain and provides some updated peak discharges for Canyons No. 1 and 2 and Dry Gulch (see Exhibits 7.3-1 and 7.3-2). The significance of this LOMR is that the area delineated as being within the 100-year floodplain was reduced significantly.

The FEMA FIS identifies flood zones for these three drainages based on the assumption that these floodplains are active alluvial fans. Alluvial fans are, by their nature, unstable and unpredictable floodplain features. Alluvial fans differ from riverine floodplains in that alluvial fans have a radial pattern with channels that are too small to convey the entire flow from an extreme flood. Flows exiting the mountain front are also heavily laden with sediment and debris. The deposition of debris, combined with the topographic shape (radial pattern), results in flows bifurcating into multiple flow paths and forming new channels on the alluvial fan surface below the mountain front that will vary with each event.

The methods used by FEMA to map the hazards associated with alluvial fans are based on the uncertainties associated with the paths that these flows can take, the potential for sediment and debris to be deposited in the upper region of the fan, and the potential for erosion or formation of new channels within the floodplain. Therefore, the fan shape of the floodplain on the FEMA FIRM is not the area that is expected to be flooded by a single event. But, since the flow could take an unpredictable direction with each event, the outer extents of the potential area that could be affected by unpredictable flow paths is shown with the potential depth and velocity associated with channel-forming flows in that region of the fan surface.

For comparison purposes, Table 7.3-2 summarizes the discharges (in cfs) for a range of flood frequencies that are shown in FEMA's 1994 FIS and shows the updated numbers summarized in the 1996 LOMR (in parentheses). These are the minimum values that must be used for floodplain-management purposes in order for FEMA to recognize any improvements that modify the floodplain or for encroachments to be regulated in the floodplain.

Note that the shaded Zone X designation on the City of Wenatchee FIRMs downstream of the Zone AO designation is defined in this case as areas of shallow 100-year flooding less than 1 foot deep.

Table 7.3-2 Summary of Discharges (in cfs)							
Flooding Source 10-year 50-year 100-year 500-year							
Canyon No. 1	500 (254)	1,200 (942)	1,650 (1,490)	3,100 (3,810)			
Canyon No. 2	600 (300)	1,450 (1,100)	1,950 (1,700)	3,700 (4,300)			
Dry Gulch	140 (73)	300 (270)	410 (428)	760 (1,090)			

Note: This table summarizes the discharges for a range of flood frequencies that are shown in FEMA's 1994 Flood Insurance Study and shows the updated numbers summarized in the 1996 FEMA Letter of Map Revision (in parentheses).

Exhibit 7.3-1 Revised Flood Hazard Zone for Canyons No. 1 and 2 (Northwest Hydraulics 1996)

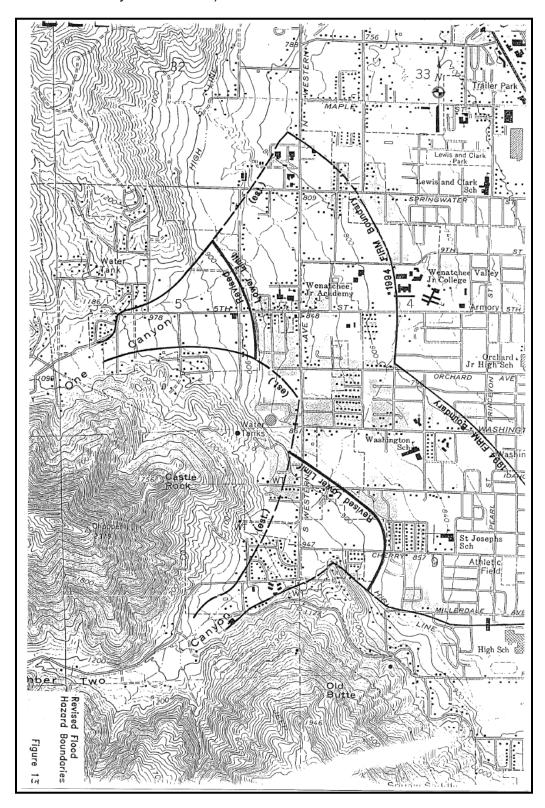
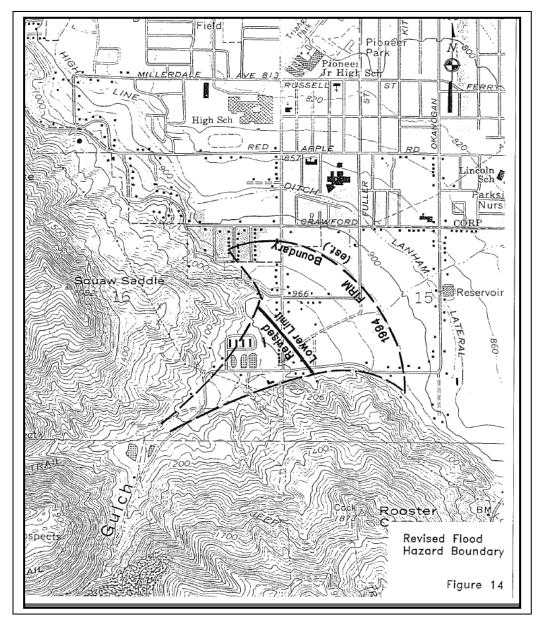


Exhibit 7.3-2. Revised Flood Hazard Zone for Dry Gulch (Northwest Hydraulics 1996)



Based on a review of the reports, Canyons No. 1 and 2 and Dry Gulch present significant risks to public property and safety due to flash flooding, mud flows, debris flows, and debris torrents. The reasons for these risks include:

- High hill slope gradient (greater than 40 percent) and friable slopes
- High rainfall intensity (greater than 1.25 inches/hour)
- Lack of vegetation (low interception rates)
- Land-use practices (historically not cultivated)

- Bare soils and shallow soils (there is evidence of rill erosion)
- Active erosion of tributaries (V-shaped profiles)

Estimates and conclusions related to mud flows, debris torrents, and sediment transport have been documented by Northwest Hydraulics (1996) for all three drainages. These conclusions are summarized below.

#### Canyon No. 1

- Significant potential for future mud flows
- Sediment yield estimate (event-based) of 12 acre-feet/year
- Route and movement of alluvial fan is unknown
- Historic mud flows estimated 200 to 400 feet wide

#### Canyon No. 2

- Mud flows in Canyon No. 2 of 3 to 5 feet high and about 1 foot at the canyon mouth
- Historic mud flows estimated greater than 400 feet wide
- Sediment yield estimate (event-based) of 20 acre-feet/year with a maximum of 40 acre-feet/year
- Significant potential for future mud flows
- Route and movement of alluvial fan is unknown

#### **Drv Gulch**

Based on previous studies, Dry Gulch is not expected to produce a high sediment load due to a "partially functioning" dam upstream.<sup>1</sup>

# 7.4 Existing Canyons and Dry Gulch Conveyance System

The City has established flow requirements (WCC 11.24.080, provided in Appendix F) for the two canyons and Dry Gulch as shown in Table 7.4-1.

Table 7.4-1 Flow-Conveyance Requirements							
Drainage Limits Flow Requirement							
No. 1 Canyon	Mouth to Columbia River	100 cfs					
No. 2 Canyon	Mouth to Columbia River	100 cfs					
Dry Gulch	Below Undammed Portion to Columbia River)	150 cfs					

<sup>&</sup>lt;sup>1</sup> "Partially functioning" should be better understood. HDR suggests evaluating this dam for structural stability, effectiveness, and ability to resist overtopping. If this dam fails, it could cause greater peak flows and could release stored sediment during a flood. Based on this review, we recommend that the City include identified modifications in project development actions, as necessary. The City should also provide enough detention to detain peak flows to an amount that the downstream system can convey.

The capacity of the existing Canyon and Dry Gulch drainage systems varies throughout the city. Previous city policies have maintained separate drainage systems for urban and canyon flows, although some combined drainage systems do exist. The Canyons/Dry Gulch drainage systems within the city limits consist of a combination of open ditches and closed pipe systems.

The actual flow-conveyance capacity for each drainage is less along many parts of the conveyance system than the stated requirement for each drainage. The open ditch systems have not been regulated, and problems occur annually in these ditches due to lack of maintenance. Where development has occurred along the drainage areas, individual developers have installed closed pipe systems per the City conveyance requirements.

Canyons No. 1 and 2 discharge flows into the urban system in a restricted drainage system along the western edge of the city, where rural low-density development transitions into higher-density urban development. Since the restricted drainage system in the urban area has not been maintained, there is a high probability that flows from a storm would leave the channel and flood the surrounding area until they are either dispersed into existing developments or ultimately enter the Wenatchee Reclamation District's High Line Canal (see Exhibit 7.3-1).

The Dry Gulch drainage system is located at the south end of Wenatchee in a less-developed area. The City has been proactive in maintaining capacity along the drainage channel that conveys Dry Gulch flows to the Columbia River. This drainage system also consists of both open and closed conveyance systems. In the transitional area between the rural drainage and the urban conveyance system, local flooding might also occur due to a lack of inlet capacity as flows enter into the closed pipe system.

# 7.5 Flood Hazard Best Management Practices

Flood hazards can be mitigated using both structural and nonstructural best management practices (BMPs). Structural BMPs are facilities designed and constructed to mitigate the adverse impacts of the flood hazard. Typical structural BMPs include check dams, stilling basins, sabo structures, levees, and training channels, while nonstructural BMPs include warning systems, proper land use, education and public participation programs, and regulatory controls.

When selecting an appropriate method for managing flood risk, the City must also consider regulatory requirements. If one of the objectives is to implement measures that will eliminate the Zone A designation on the FEMA FIRMs, there are limited options that will accomplish this goal. Section 7.3 describes how FEMA views hazards associated with alluvial fans as a result of the sediment- and debris-laden flows and unique geographic characteristics of an active alluvial fan. In order for FEMA to recognize the flood-control measure as being adequate for revising the FIRMs, the measures must include a method for controlling the sediment and debris that is exiting the canyons, reduce the flow rates through storage to a flow rate that the downstream facilities can convey, and provide enough downstream erosion protection to the toe of the alluvial fan and through the city.

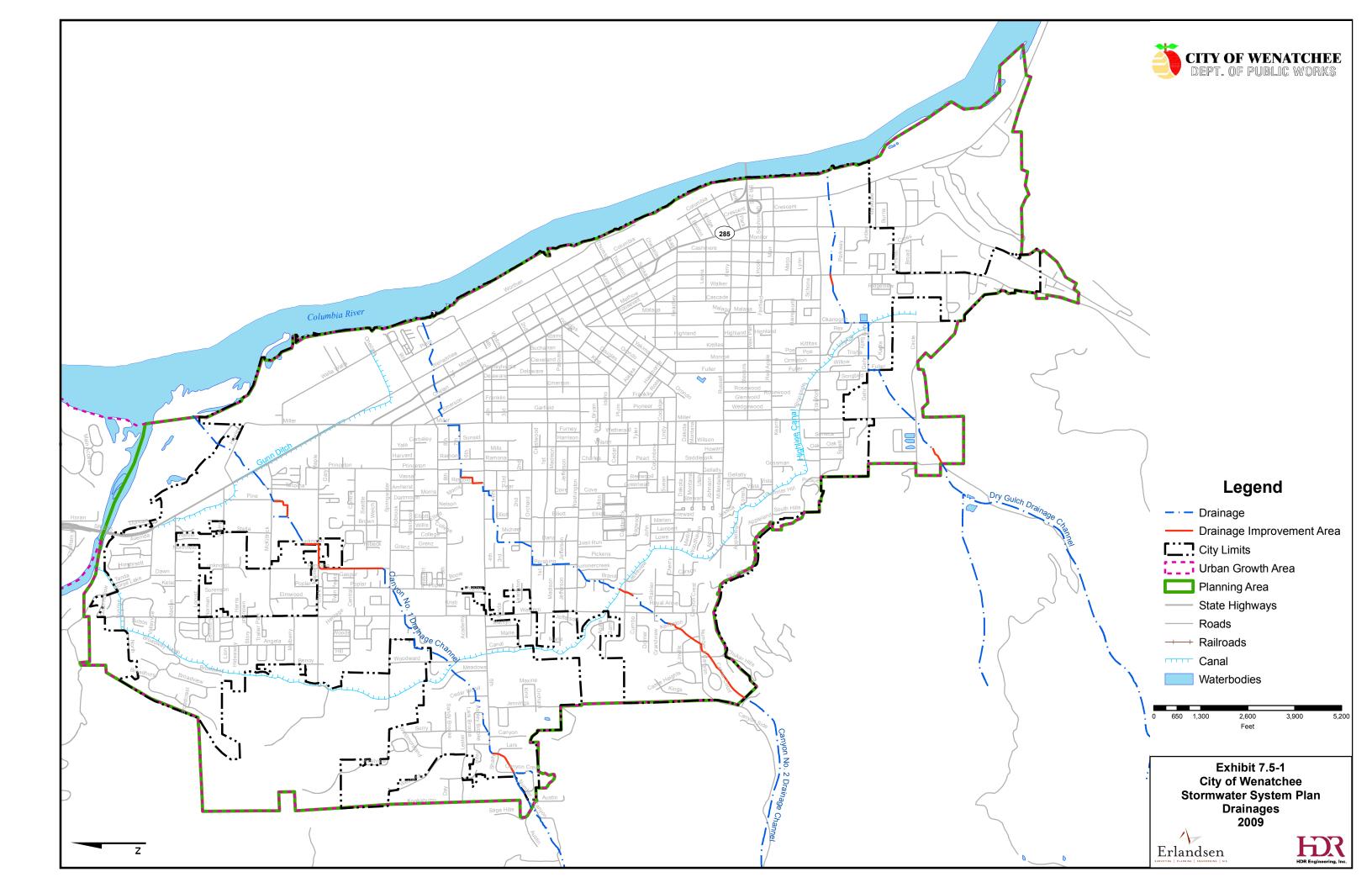
#### 7.5.1 Structural Flood Hazard BMPs

- 1. Corps Study (1974). This study recommends the use of debris-control dams in Canyons No. 1 and 2 and large concrete conveyance structures to route the flows from the dams to the Columbia River. Total project construction costs were estimated at about \$73 million (January 2009 updated cost). This concept is consistent with what FEMA would require for eliminating the alluvial fan flood zone. However, erosion protection of the channels from the outlet of the debris-control dam to the toe of the alluvial fan will also be required. The City would either need to demonstrate there is no erosion potential or provide erosion protection as necessary. Flows would also need to be metered out of the control structure and/or a hardened conveyance channel downstream to the point where flows enter the conveyance system in the city.
- 2. Chelan County Public Works (1977). This study proposed large, flat, grassy areas between 10 to 20 acres in area and 5 to 6 feet deep at the mouths of Canyons No. 1 and 2. These areas could also be used for recreation. The study did not include cost estimates. While this concept, combined with structural measures needed to direct flow to these areas, might be effective at capturing the majority of the sediment reaching that point in the system, it would not remove the Zone A designation on the FEMA FIRM, since flows could be directed by debris accumulation to a path that could bypass these facilities.
- 3. Munson Engineers Wenatchee Area Flood Hazard Report (1980). Munson Engineers proposed to construct debris dams in Canyons No. 1 and 2 and Dry Gulch and stilling basins in the developed areas. The estimated cost for these structures was about \$8 million (January 2009 updated cost) but did not include real estate. HDR assumes that these facilities are smaller than those proposed by the Corps because they were intended to capture only sediment and debris and would not have enough volume to decrease peak flows. Without enough volume to decrease peak flows and erosion-protection measures in the downstream channel, the floodplain as shown on the FEMA FIRM might be further reduced but would not be eliminated without adequate conveyance improvements. The necessary erosion-protection and conveyance improvements are not included in the Munson cost estimate. The cost of conveyance improvements through the urban area would be high due to the size of facilities needed, utility relocations, reconstruction of disturbed infrastructure, and right-of-way acquisition needs.
- 4. Hammond Collier, Wade, Livingstone Stormwater Management Plan (2000). Based on designs from the Corps study and the Munson report and using new information from the Corps Zintel Canyon Dam Project, this plan proposed the following:
  - Seven separate structures over the three basins, each with an estimated 100 acre-feet of storage. The proposed structures could include either complete retention of flows or could be used as detention facilities, which then could be connected to the city's drain system. This concept is similar to the concept that was proposed by the Corps. This concept, together with erosion-control measures for the downstream channel, would be necessary to eliminate the Zone AO designation shown on the FEMA FIRM.

- Estimates to construct the detention system were about \$13 to \$18 million plus an additional \$6 million to upgrade the existing drain system (January 2009 updated cost). See Exhibit 7.5-1 for drainage system improvement areas.
- The city's current stormwater system isn't designed to handle flows above the 100- to 150-cfs threshold for Dry Gulch and the Canyons. The actual capacity is estimated to be even less than this. Estimated bulked (with sediment) maximum flows of 3,000 cfs would constitute a 20-fold increase in existing city stormwater flow capacity. Constructing conveyance facilities of this size in an already heavily urbanized area would be costly.

### 7.5.2 Non-structural Flood Hazard BMPs

- 1. Hazard Mapping Identify areas of danger. This BMP is addressed through the FEMA FIS and the associated floodplain mapping on the FIRM, since that is the purpose of the FIS and the associated delineation of the floodplain. Canyons No. 1 and 2 and Dry Gulch are each shown on the FIRM and updated LOMR, and portions of the city are identified as Special Flood Hazard Areas (SFHA) as a result of flooding from these sources. These SFHA are identified on the FIRM and are updated on the 1996 LOMR as areas that are potentially subject to inundation by a 100-year flood.
- Land Use Restrict or limit development in identified hazard areas. This BMP is addressed through the City's existing ordinances. Chapter 2.05, Flood Hazard Prevention, was adopted by the City as a requirement for participation in FEMA's NFIP. Through the provisions in this ordinance, the City regulates all development within the SFHA to reduce the potential for flood damages. In addition, the City has adopted Ordinance No. 2009-11, which deals with Resource Lands and Critical Area development, based on the Washington State Growth Management Act. This ordinance identifies Frequently Flooded Areas, which are defined as areas subject to a 1 percent or greater chance of flooding in any given year, and references the City's Flood Hazard Prevention ordinance for regulating all development in Frequently Flooded Areas. The City's existing Flood Hazard Prevention ordinance contains only the minimum provisions required by FEMA. If the City chooses to, it could develop and implement more-restrictive provisions, which would provide an additional degree of protection for future construction in the SFHA or areas outside the SFHA that might also be subject to potential damages from flooding and debris flows from Canyons No. 1 and 2 and Dry Gulch.
- 3. Insurance Help those already in hazard areas. This BMP is also addressed through the City's participation in the NFIP by making federal flood insurance available for all residents (land owners as well as renters) with developed property in the city. In locations identified as being within an SFHA, lending institutions typically require the purchase of flood insurance before constructing a building and as a condition for obtaining any federally insured loan in an SFHA. In instances where the purchase of flood insurance is not mandated, anyone can purchase flood insurance for a building and its contents, whether or not the building is located within the identified SFHA. At the present time, there are 330 flood-insurance policies in place within the city. As noted in Section 7.3, the shaded Zone X designation in Wenatchee is intended to represent areas subject to flooding during a 100-year storm with shallow depths. Although flood insurance is not mandatory in these areas, it would



be prudent for property owners in the shaded Zone X to also obtain flood insurance to insure against the risk to which they are exposed. Insurance costs for properties in Zone X are significantly less than in Zone A (SFHA).

#### 7.6 Discussion and Recommendations

# 7.6.1 Debris- and Flow-Control Improvement Options

Runoff from the canyons poses a significant risk to public property and safety. A number of studies have been conducted over the years. These studies have generally concluded that existing drainage facilities are not able to handle such storms and that some form of debris and flow control is recommended. The Corps recommended the construction of debris-control dams and conveyance structures extending into the urban area. The County proposed debris control by providing open areas that could be used to store floodwater and debris during a large storm and used for recreation the rest of the time. Munson Engineers suggested the use of channel storage within the canyons, debris dams, and stilling basins within the developed areas. Hammond Collier, Wade, Livingstone proposed a mitigation program that adapted elements from the Corps and Munson Engineers and was similar in function to the Corps Zintel Canyon Dam Project, which provides flood protection to the city of Kennewick.

Constructing such projects requires a significant investment. Based on our review of existing conditions and previous studies, HDR has identified two structural alternatives: (1) a debris basin that controls only sediment and debris in the canyon above the apex of the alluvial fans with conveyance improvements designed to resist erosion through the alluvial fan and downstream urban area, or (2) detention basins in the canyon above the apex of the alluvial fans with sediment-capture features and enough storage volume and controls to reduce the peak flows from the basin to a flow rate conveyable by existing downstream facilities. Due to the potential cost of large conveyance facilities in the urbanized area, alternative 2 is likely to be the more cost-effective solution. Both of these alternatives could eliminate the Zone AO designation on the FEMA FIRM if the conveyance improvements extend to the river, provided this is the City's long-term goal.

As the City evaluates detention basin opportunities, it should seek to better understand the "partially functioning" condition of the Dry Gulch dam. HDR suggests evaluating the existing dam for structural stability, effectiveness, and ability to resist overtopping. If this dam fails, it could cause greater peak flows and could release stored sediment during a flood. Based on this review, we recommend that the City include identified modifications in project development actions, as necessary. The City should also provide enough detention to detain peak flows to an amount that the downstream system can convey.

# 7.6.2 Conveyance System Improvements

Additional incremental improvements can also be made to improve existing conditions based on the City's near- and long-term objectives. Downstream conveyance improvements are needed. These include both improvements to the existing conveyance systems and possibly diverting part of the Canyons No. 1 and 2 flows into the city's stormwater system.

It should be noted that flood events from the canyons are not expected to correspond with rain events within the urban area. Consequently, the existing conveyance system

would be available to mitigate flooding from the canyons. Also, flooding from the canyons is expecting to result primarily in sediment and debris, which will be addressed by the improvements to the existing stormwater system, which will include sediment removal.

Based on the system analysis (see Chapter 6), approximate flow rates of 28 cfs for No. 1 Canyon and 26 cfs for No. 2 Canyon could be conveyed through the existing stormwater system in addition to using the existing conveyance channels if they are upgraded to their flow-conveyance targets. These rates are based on the capacity of the urban collection system along the edge of the planning area.

The average capacity of the existing Dry Gulch closed conveyance system is about 80 cfs. Additional system improvements would be necessary to upgrade the conveyance system's capacity to handle these flows. The cost of upgrading the Dry Gulch conveyance system is less than the cost of improving conveyance below the canyons.

Additionally, HDR recommends that the City implement nonstructural BMPs to minimize risks to public property and safety from flood hazards.

# 7.6.3 Funding Options

The City has at least three options for initiating a study to evaluate structural alternatives and focus on the desired, most cost-effective approach for design and construction.

#### Option 1

Option 1 is to reinitiate discussions with the Corps through one of the programs in its Civil Works Program: the general Civil Works Process and the Continuing Authorities Program (CAP).

The Civil Works Process requires both congressional authorization and appropriation for studies, design, and construction funding. The Civil Works Project process is often summarized by the Corps as having 21 steps, as outlined in Appendix G. These steps integrate the congressional authorization and appropriations requirements with the administrative actions required for completion by the Corps in cooperation with the non-federal sponsor.

The CAP provides access to the Corps to assist on a wide variety of technical problems associated with shoreline and stream bank erosion, navigation, flood damage reduction, and environmental restoration. This program is limited to \$7 million for the federal share. The cost share is 65% federal and 35% non-federal. Appendix G provides a more detailed description of the requirements and steps for these two approaches.

Other Corps programs also exist, such as Planning Assistance to States and Flood Plain Management Services. The Planning Assistance to States (Section 22) Program typically funds one project per state or tribe per year and generally cost from \$20,000 to \$150,000. Studies are cost shared with 50 percent of the costs furnished by a local sponsor and 50 percent by the Corps. The Flood Plain Management Services program provides authority for the Corps to use its technical expertise in floodplain management matters to help both public and private interests. On request, program services are provided to state, regional, and local governments, Native American tribes, and other non-federal public agencies without charge.

#### Option 2

Option 2 is to pursue a similar effort described for Corps with the Natural Resources Conservation Service (NRCS). Additional information can be provided if the City wants to understand what this option might involve.

#### Option 3

Securing any federal funding is going to take time and significant coordination and communications. If the City is interested in trying to meet a shorter project development schedule, Option 3 might be appropriate. Option 3 is for the City and any local partnering agencies to seek Flood Control Assistance Account Program (FCAAP) funding for a flood hazard reduction technical study and then consider how to fund the project with state and local funding. Dedicated local revenue source(s) would be needed to support this option, such as a local improvement district (LID) as discussed in the City's 1999 Storm Water Management Plan. This can allow the City to meet the FEMA requirements or other more modest flood-hazard reduction goals without layering on the additional requirements and process that other federal agencies include in a joint effort. Often the federal options can result in increased project planning and design and construction costs and can extend the project development schedule.

One challenge with Option 3 is that FCAAP funding is limited for the state 2010–2011 biennium. Ecology might not be accepting any new applications during this state biennium budget period. FCAAP grant funding might not be available until 2012 or beyond (personal communication, Bev Huether, Ecology, June 1, 2009).

An additional funding option might be seeking FEMA funding by having the Canyon hazards identified in the Chelan County Hazard Mitigation Plan. With the projects identified in the Hazard Mitigation Plan, the City can apply for funding a Hazard Mitigation Project to mitigate this flooding problem. Chelan County and the City of Wenatchee have an existing multi-jurisdictional Hazard Mitigation Plan that was approved by FEMA in February 2005. Hazard Mitigation Plans are required to be updated every 5 years, so the Plan will need to be updated by February 2010.

Applications for FEMA funding of Hazard Mitigation Plans or projects are filed through the Washington State Emergency Management Division during an open period for filing grant applications. Typically, grants for plans or projects are funded at 75% federal/state funding with a 25% local match.

Regardless the funding path chosen, HDR recommends that the City solidify its flood risk reduction goals and then develop some updated structural alternatives to meet these goals. Order-of-magnitude costs need to be identified before determining which funding approach is most suitable for the City's situation. HDR further recommends that the City coordinate closely with FEMA Region X staff on design criteria to meet federal flood-control requirements.

# 8 Water Quality

## 8.1 Introduction

This chapter describes general water quality concerns, lists the existing facilities with water quality treatment features, and summarizes BMPs to protect water quality.

# 8.2 General Water Quality Concerns

Water quality is a concern in the Wenatchee Valley since urban stormwater discharges to the Columbia River. The City has been addressing water quality through the stormwater program development, street sweeping, stormwater system maintenance, road projects and other projects such as the Snow Melt Facility.

# 8.2.1 Land Use and Water Quality

Pollutants are classified by the EPA as originating from either "point" or "nonpoint" sources. Point sources are usually pipes from sewage treatment plants or industrial facilities. Nonpoint source pollution refers to pollution with "no obvious point of discharge" (Ecology, no date). Table 8.2-1 lists many typical nonpoint sources of pollution and the pollutants that are commonly associated with different land-use types. Table 8.2-2 provides estimated concentrations and load estimates for pollutants present in stormwater runoff.

Table 8.2-1 Land Uses and Associated Nonpoint Source Pollutants									
Land Use	Nutrients	Oils/ Grease	Toxic Compounds	Sediment	Organic Materials	Pathogens/ Bacteria			
Residential Development									
Clearing and Grading	x	X		x	x	x			
Construction	X	Х	х	х					
Roof Wash-off	X		X	X					
Yard Debris	X				X	X			
Lawn and Landscape Runoff	x		x	x	x	x			
Riparian Vegetation Removal	x			x					
Septic Systems	X		X		X	X			
Commercial									
Automotive Shops	X	Х	X						
Car and Truck Washes	x	X	x						
Landscaping and Nurseries	х		x	x	х				
Restaurants	х	Х			х				
Shopping Centers	X	X	X		X				
Industrial									
Concrete Batch Plant		x		x					
Swim Pool Manufacturing			х						

Table 8.2-1 Land Uses and Associated Nonpoint Source Pollutants						
Land Use	Nutrients	Oils/ Grease	Toxic Compounds	Sediment	Organic Materials	Pathogens/ Bacteria
High-Tech Manufacturing			x			
Agriculture						
Irrigation	х		х	х	х	
Livestock Grazing	х			х	х	X
Manure Disposal	х			х	х	X
Crop Production	х		х	х	х	
Other Sources						
Transportation	х	Х	х			
Hazardous Spills	х	Х	х		х	X
Illicit Connections	х	Х	х		х	х
Landfills	x	X	х		х	X

Source: McGuiness, et al. 1994

Table 8.2-2 Water Quality Characteristics of Runoff from Residential and Commercial Areas <sup>1</sup>								
Constituent	Average Residential or Commercial Site Concentration	Weighted Mean Residential or Commercial Site Concentration	Nationwide Urban Runoff Program Recommendations for Load Estimates					
Total Suspended Solids (TSS)	239.00 mg/l	180.00 mg/l	180.00 to 548.00 mg/l					
Biochemical Oxygen Demand (BOD)	12.00 mg/l	12.00 mg/l	12.00 to 19.00 mg/l					
Chemical Oxygen Demand (COD)	94.00 mg/l	82.00 mg/l	82.00 to178.00 mg/l					
Total Phosphorus	0.50 mg/l	0.42 mg/l	0.42 to 0.88 mg/l					
Soluble Phosphorus	0.15 mg/l	0.15 mg/l	0.15 to 0.28 mg/l					
Total Kjehldahl Nitrogen	2.30 mg/l	1.90 mg/l	1.90 to 4.18 mg/l					
NO2 +3 - N	1.40 mg/l	0.86 mg/l	0.86 to 2.20 mg/l					
Total Copper	53.00 μg/l	43.00 μg/l	43.00 to118.00 μg/l					
Total Lead	238.00 μg/l	182.00 μg/l	182.00 to 443.00 μg/l					
Total Zinc	353.00 μg/l	202.00 μg/l	202.00 to 633.00 µg/l					

<sup>1.</sup> Developed from results of the Nationwide Urban Runoff Program (EPA 1983)

Pollutants in stormwater runoff from roads and highways include oil and grease, polynuclear aromatic hydrocarbons (PAHs), lead, zinc, copper, cadmium, sediments, and road salts and other anti-icers. In the city, runoff from roads is assumed to be higher along the eastern border where a large portion of the city's business and commercial land use is located.

In addition to the pollutants generated from roads, runoff from commercial and business areas can also contain pollutants generated by residential or industrial areas, depending on which businesses are present. For example, an automotive shop could generate oil and grease in runoff, while a nursery may result in a higher amount of sediment in stormwater runoff. Some home-based businesses also have the potential of generating

polluted discharges. Public education and outreach may be most effective with home-based businesses.

Residential areas generate the same pollutants as road runoff along with herbicides, pesticides, nutrients (from fertilizers and animal wastes), and bacteria, viruses, and other pathogens (from animal wastes) (Ecology 2004). Rural residential areas might generate more viruses and other pathogens due to the higher prevalence of animals, whereas high-density residential areas that include multifamily homes would be anticipated to generate a higher concentration of petroleum in storm runoff. Sediment erosion from residential areas is mostly a concern during construction periods before land cover or vegetation is established.

Industrial areas generate stormwater runoff that contains heavy metals, sediments, and human-made organic pollutants including phthalates, PAHs, and other petroleum hydrocarbons.

# 8.2.2 Total Maximum Daily Load Requirements

A TMDL (total maximum daily load) is the maximum amount of pollutant that a water body can receive without exceeding water quality standards. In Washington State, TMDL also refers to the planning process in which water bodies that do not meet water quality standards are studied and strategies to reduce pollutants are developed and implemented. EPA approved in 2009 the Ecology developed TMDL for pH and dissolved oxygen in the Wenatchee River (Ecology 2009a).

A TMDL exists on the Columbia River for total dissolved gas. According to Ecology, this TMDL sets total dissolved gas loading capacities and allocations for the Columbia River, primarily affecting fish passage at Columbia River dams (Ecology 2008). EPA also began efforts on a temperature TMDL for the Columbia River but suspended this effort "to allow necessary discussions and information exchange" (Ecology 2009b).

#### 8.2.3 National Pollutant Discharge Elimination System Requirements

To comply with CWA regulations, the City of Wenatchee, City of East Wenatchee, Chelan County, and Douglas County have joined together to create a joint stormwater program. In 1999, the EPA introduced Phase II of the NPDES program, which requires a permit for stormwater discharges to certain municipal separate storm sewer systems (MS4s) and construction sites greater than 1 acre of land. In Washington State, Ecology administers the NPDES program on behalf of the EPA.

The Wenatchee Valley Stormwater Advisory Committee (WVSTAC) was formed as a cooperative effort to address the requirements of the permit and to collaborate on regional stormwater issues. The committee, which consists of agency representatives from the City of Wenatchee, City of East Wenatchee, Douglas County, and Chelan County, was formed under an interlocal agreement among the jurisdictions. In 2008, the WVSTAC developed an SWMP description that describes how the Cities and Counties are addressing the NPDES requirements. Under the SWMP, the City of Wenatchee is doing or planning to do the following:

- Participate in a public education and outreach program and facilitate public involvement.
- Adopt an illicit discharge detection and elimination (IDDE) ordinance prohibiting certain non-stormwater discharges into the MS4.
- Develop an IDDE plan with the City of East Wenatchee and the Counties to find, identify, and eliminate unknown pollutant discharges to the storm drainage system.
- Develop an illicit discharge spill response plan with the City of East Wenatchee and the Counties that will identify appropriate actions when a spill occurs.
- Adopt a construction and post-construction site stormwater ordinance requiring erosion and sediment controls in compliance with the SWMM for Eastern Washington.
- Adopt and implement procedures for reviewing construction site plans that consider potential water quality impacts.
- Provide information to construction site operators on how to install and maintain effective erosion and sediment controls and how to comply with NPDES permit requirements.
- Develop an operation and maintenance program for municipal operations with the goal of preventing or reducing pollutant runoff from municipal operations.

# 8.3 Best Management Practices

In the Stormwater Manual for Eastern Washington, Ecology presents BMPs for stormwater management. BMPs are technically sound stormwater management practices that are designed to protect water quality. Stormwater management BMPs can be categorized into three different types: source control, water quality treatment, and flow control. Source-control BMPs are designed to prevent stormwater pollution, while water quality BMPs are measures that are designed to remove pollutants from stormwater. Lastly, flow-control BMPs are intended to control the rate, frequency, and/or flow duration of stormwater runoff to prevent impacts to downstream water bodies (Ecology 2004).

This section provides brief summaries of some BMPs that may be appropriate in Wenatchee for managing stormwater. Detailed descriptions of these BMPs can be found in the Stormwater Manual for Eastern Washington and the EPA Phase II Menu of BMPs.

#### 8.3.1 Source Control BMPs

#### **Catch Basins**

Catch basins are openings to the storm drain system that usually include a grate to filter out leaves and debris, a sump that captures sediment, and a hooded outlet that prevents debris from entering the storm drain system.

#### Oil/Water Separators

Oil/water separators are used to capture spills or at sites that have high oil and grease loading as a form of source control. Separators are generally not well suited for regionalized or basin-level stormwater management.

# 8.3.2 Water Quality BMPs

#### **Surface Infiltration and Bio-infiltration**

Infiltration BMPs remove pollutants from stormwater by percolating runoff through soil and recharging groundwater. Examples of infiltration systems include infiltration ponds, infiltration trenches, drywells, retention ponds, and grassy swales. These facilities remove pollutants and recharge aquifers (Ecology 2004).

#### Biofiltration

Biofiltration facilities use vegetation to remove pollutants by sedimentation, filtration, soil sorption, or plant uptake (Ecology 2004). Biofiltration systems, such as swales and vegetated filter strips, can remove low concentrations and quantities of total suspended solids (TSS), heavy metals, petroleum hydrocarbons, and nutrients from stormwater (Ecology 2004).

#### Filtration

Filtration BMPs remove pollutants from stormwater through engineered natural soils or other imported media. A sand filtration system includes a pretreatment system, flow spreader, a sand bed, and the underdrain piping.

## **Phosphorus Treatment**

For phosphorus treatment, the Eastern Washington Manual lists the following treatment options. Table 8.3-1 defines treatment trains for phosphorus removal. Note that the manual lists several special arid climate and cold weather considerations that are applicable to the city. See Sections 5.2.2 and 5.2.3 of the Manual for further information.

#### **Metals Treatment**

For metals treatment, the Eastern Washington Manual lists several treatment options primarily using infiltration or sand filters. Metals treatment is required only in certain conditions, as defined in the manual.

# 8.3.3 Flow Control BMPs

# **Detention Facilities**

Detention facilities are structures that are designed to temporarily store surface water runoff and then release the water at a controlled rate. Underground storage tanks, pond storage areas, and enlarged channels and canals are examples of detention facilities. Detention facilities can also include water quality treatment by incorporating bio-filtration swales, filters, sedimentation basins, and wetponds.

#### **Retention Facilities**

Retention facilities are structures that are designed to store surface water runoff without releasing the water beyond the structure. Stored water is then subject to infiltration, evaporation, transportation, or reuse. Evaporation ponds, surface depressions, infiltration drywells, trenches, and ponds are examples of retention facilities.

#### Subsurface Infiltration

Subsurface infiltration systems are facilities that discharge stormwater directly into the ground, including drywells, pipe or french drains, and drain fields (Ecology 2004). Subsurface infiltration is subject to the Underground Injection Control (UIC) rule.

# 8.3.4 Emerging Technologies

Ecology provides guidance in the Eastern Washington Manual about emerging technologies that, although they have not been fully evaluated, appear to remove a desirable level of stormwater pollutants. In addition, Ecology keeps an updated list of approved emerging technologies on its website along with the technologies' application criteria and performance limits. Examples of emerging technologies include media filters, amended sand filters, catch basin inserts, manufactured storm drain structures, and high-efficiency street sweepers (Ecology 2004).

The City of Wenatchee has developed a prototype snow melt facility that eliminates the need for large areas of land for snow storage and provides water quality treatment. The City will be pursuing a pilot study to develop this potential BMP for snow removal.

# 8.4 Existing Facilities with Water Quality Treatment

Wenatchee benefits from several existing water quality treatment facilities within the stormwater system. Table 8.4-1 identifies the existing water quality treatment facilities in the city including name, location, type(s) of treatment, and other descriptive information. Additionally, the City has and will continue to require on-site source control and BMPs for applicable commercial development. Exhibit 8.4-1 shows the location of existing water quality facilities.

Table 8.4-1 Existing Water Quality Treatment Facilities in the City of Wenatchee									
Facility Name	Location	Type of Facility	Treatment Level						
Linden Tree Park	Riverfront Park, Ninth and Walla	Wetpool/Wetpond	Regional level facility; provides nutrient and sediment/heavy metals removal for entire M-500 basin.						
Fifth Street Stormwater Filter	Fifth Street and North Mission Street	Contech StormFilter, siphon-actuated filtration system; consists of three bays: inlet, treatment, and outlet.	Localized facility; provides oil and sediment/heavy metals removal along a high- traffic arterial.						

Existing W	Table 8.4-1 Existing Water Quality Treatment Facilities in the City of Wenatchee							
Facility Name	Location	Type of Facility	Treatment Level					
North Wenatchee Stormwater System	North Wenatchee Ave. behind commercial properties and adjacent to Burlington North Santa Fe Railway. Extends north from behind 1921 N. Wenatchee Ave. to the just south of the Wenatchee River.	Bio-infiltration swale and dry pond; two bio- infiltration swales in series followed by a dry	Regional level facility; provides sediment/heavy metals and oil and nutrient removal through a closed system with no surface water connection. Connection to adjacent PUD wetlands has been abandoned.					
Walla Walla Stormwater System	Walla Walla Ave. between Ninth Street and North Miller Street	Infiltration trenches and subsurface infiltration	Localized facility for improvements along Walla Walla Ave; provides sediment/heavy metals removal along a growing mixed used zone of the City with increasing traffic.					
Walnut-Hawley Swales	Walnut Street from Pine Street and North Wenatchee Avenue	Bio-infiltration swale and small retention pond	Localized facility; provides nutrient, oil, and sediment/heavy metals removal for a portion of a high-traffic intersection in a heavily commercialized zone.					
Stella Street Stormwater System	Stella Street between McKittrick and Walnut	Subsurface infiltration	Localized facility; provides nutrient, oil, and sediment/heavy metals removal for the City's Public Works facilities.					
Broadview Pond	West of Maiden Lane behind 2018 Maiden Lane	Dry pond	Regional level facility; provides sediment removal for residential Basin M-7000.					
Riverside Drive	Riverside Drive and Island View	Contech StormFilter, siphon-actuated filtration system; comprised of three bays: inlet, treatment, and outlet	Localized facility; provides oil and sediment/heavy metals removal along the growing riverfront revitalization.					
Red Hawk Canyon Pond	Fifth Street west of the Highline Canal	Dry pond	Localized facility; provides sediment removal for residential subdivision.					

Table 8.4-1 Existing Water Quality Treatment Facilities in the City of Wenatchee							
Facility Name	Location	Type of Facility	Treatment Level				
Pierre Street		siphon-actuated filtration system; consists of three	Localized facility; provides oil and sediment/heavy metals removal along the growing riverfront revitalization.				

# 8.5 Water Quality and the Capital Improvement Plan

Stormwater runoff quality and treatment across the City's basins require separate management efforts that depend on the development level within the basin, the pollutant loading anticipated from the proposed and existing land uses, as well the more practical constraint of available land for regional facilities. Development within the city is relatively constrained between the Columbia River and the mountain slopes to the West. Much of the city's developable land exists in basins at the north and south ends of the city. The stormwater runoff quality and treatment discussion in this section will be divided into basins with developable land and basins more focused on redevelopment. Exhibit 8.4-1 shows the location of basins discussed in this section.

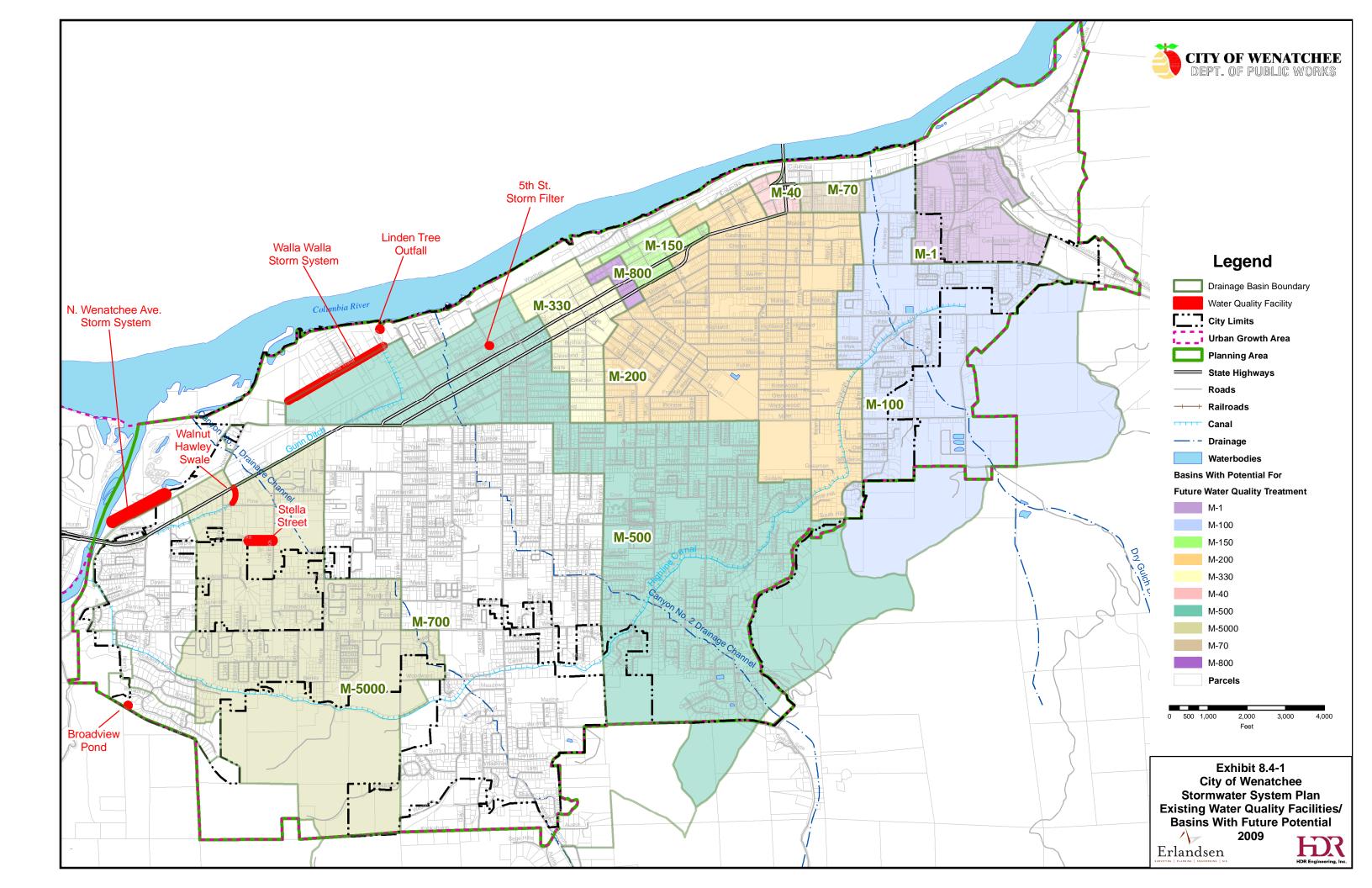
**Development Basins (M-1, 100, 5000)** Basins identified with significant developable land should be considered by the City, regardless of the proposed land use, for the location and sizing of future regional water quality facilities while real estate is available. This will allow the City to develop the most cost effective solutions at the pace of development, rather than reacting to water quality issues in the receiving water body.

Basins M-1 and M-100, with cooperation from Chelan County, will be developed under appropriate water quality design guidance of Ecology's Stormwater Manual for Eastern Washington and the adopted design standards of the City of Wenatchee and Chelan County. City and county infrastructure projects supporting the development of these basins will need to account for, and treat, storm runoff with appropriate water quality BMPs at the basin or subbasin level. Strategically planned regional water quality can allow city and county infrastructure projects exceeding water quality thresholds to be constructed under a cost effective regional treatment concept and avoid the inefficiencies of numerous individual facilities.

For the future development in basin M-5000, the most effective placement for regional level facilities is a challenge because the downstream end of the basin has the least amount of available land and the largest potential for pollutant loading based on comprehensive land use. The City should explore opportunities to combine regional treatment in basin M-5000 with adjacent regional facilities, such as the N. Wenatchee Ave. Storm System through proper development and connection of storm conveyance.

# Redevelopment Basins (M-40, 70, 150, 330, 800 and lower portions of 200, 500, 700)

A significant challenge with most municipal stormwater water quality programs is that areas of the city that often have the greatest need for water quality BMPs are typically the same locations that are fully built out with little real estate to develop regional level



water quality facilities. One the most significant areas for the City's stormwater quality program is the downtown corridor that experiences heavy volumes of vehicle traffic and is lined with commercial and light and heavy industrial land uses. There are two feasible opportunities to incorporate water quality facilities; private/public redevelopment of existing parcels and right-of-way public works projects.

For redevelopment, one option is to adopt low-impact development standards, lessoning the burden on the City's stormwater system and to reduce the potential of pollutant loading by constructing smarter, less costly, and less environmentally impactful development. Currently, there is discussion within Ecology and amongst communities in Eastern Washington to develop a standardized low impact development manual that the City could chose to adopt in the future. Additionally, parcels that may be redeveloped near or adjacent to existing outfalls and drainage ways could investigate alternatives with the City that may be able to treat partial basin flows. Together, the City and private developers may find solutions to meet the water quality requirements of not only the redevelopment project, but also enhance regional water quality within the basin.

As the City's public works projects within the right-of-way move forward in the downtown corridor, the City should consider the inclusion of smaller, more localized facilities in order to remove oil, sediment, and heavy metal laden runoff from high-traffic collectors and arterials. Additionally, heavily developed commercial and industrial areas containing customer and fleet parking should be encouraged to retrofit existing systems with appropriate BMPs as redevelopment permits. An example of a small local water quality facility would be the City owned and maintained Contech StormFilter installed at Fifth Street and Wenatchee Ave. Businesses along the corridor will also respond to an effective IDDE and facility stormwater pollution prevention planning, as implemented under the NPDES Phase II permitting.

#### **Partnering Agencies**

Beyond the development and redevelopment activities, the City should explore opportunities to combine efforts with both Chelan County PUD No.1 and Chelan County in projects that promote water quality and treatment enhancement of stormwater runoff. A recent example of this cooperation has fostered the construction and development of the Linden Tree Water Quality Facility that serves basin M-500 within the city, along with providing amenities for the PUD's Riverfront Park system. Similar opportunities should be investigated for areas in the southern downtown corridor with basins M-200, M-40, and M-70.

For areas outside the city limits but within the UGA and county controlled tributary basins, the City should investigate similar treatment enhancement opportunities to the Linden Tree Facility. Tributary areas within the city and county draining to Squilchuck Creek in basin M-1 could be modified to have an improvement that provides regional treatment, as well as a park amenity for local growth and development.

#### CIP Projects

There are three identified water quality projects beyond the recommendations stated above that should receive directed funding for construction through the City's Stormwater Management Program. They are the City's Snow Melt Facility, Phase II of the Linden Tree Facility, and the City's Decant Facility. Each of these projects is fully described in Chapter 9.

# 9 Structural Improvements

# 9.1 Introduction

This chapter presents the Capital Improvement Plan (CIP) to address the City's existing and future stormwater drainage and infrastructure needs. HDR and Erlandsen recommend several CIP projects to address system deficiencies and drainage problem areas. Recommended projects were developed based on historical records, staff information, and comprehensive modeling. This chapter describes the CIP development process, the CIP projects, and sources of funding.

# 9.2 Capital Improvement Plan Projects

Recommended CIP projects are designated as conveyance projects, extension projects, or water quality projects. The details of these projects are provided in Section 9.2.1. A summary table and exhibit are provided in Section 9.2.2.

#### **CIP Project Prioritization**

CIP projects were prioritized based on improvements identified but not completed in the 1999 Comprehensive Stormwater Management Plan, on Maintenance and Problem Records, and on local knowledge of problem areas. When prioritizing projects, HDR and Erlandsen also took into account upcoming road projects and assumed a \$500,000 budget per year for capital projects through 2015. Projects in developed areas received priority over those in undeveloped areas. From the list, projects were categorized as a Short-Term (0- to 2-year), Mid-Term (2- to 5-year), or Long-Term (5- to 10-year) improvements. Developed areas where flooding or conveyance problems could cause property damage were categorized as Short-Term improvements. Mid-Term projects consist of projects in areas where HDR and Erlandsen estimated that development will occur in the immediate future and projects involving roadway reconstruction in an urban area. Long-Term projects are those that need to be completed but for which there is no immediate need for the improvement, either because the area is currently undeveloped or because there are no identified problems associated with the local runoff.

#### **CIP Project Costs**

Costs for the projects were developed based on 2008 and 2009 historical bid information for the Wenatchee Area including the Rock Island Road Reconstruction project for the City of East Wenatchee and the Riverside Drive Project for the City of Wenatchee. From these and other representative projects that were used as a basis, individual unit costs were extracted to determine an average construction cost for each of the different materials that would be used in a given project. For those costs where no local information was available, material suppliers were contacted to obtain pipe and structure costs for the various large-diameter components since these items are not typically used in projects in the north-central Washington area. Paving and trenching costs are based on city requirements for trench patch sections that were averaged into a linear-foot cost based on the diameter of the pipe and anticipated trench patch width. Structure costs were further developed as individual structure costs inclusive of all installation costs and were assumed to be located every 300 feet along the length of the pipe. Table 9.2-1 provides pipe cost information per linear foot, and Table 9.2-2 provides catch basin cost information. Appendix H provides more detailed cost information for each of the projects described in Section 9.2-1.

	Table 9.2-1 Pipe Cost Breakdown per Linear Foot									
			Solid PVC	Solid PVC	PVC or ADS	PVC or ADS	PVC or ADS	Concrete	Concrete	Concrete
Item	Description of Item	Unit	12"	18"	24"	30"	36"	48"	60"	72"
1	Pipe Cost	LF	\$6.00	\$13.00	\$25.00	\$37.00	\$47.00	\$130.00	\$180.00	\$243.00
2	Trench Excavation and Backfill	LF	\$22.50	\$25.00	\$27.00	\$30.00	\$35.00	\$40.00	\$50.00	\$60.00
3	Pipe Bedding	LF	\$3.00	\$4.00	\$5.50	\$7.00	\$9.00	\$13.00	\$17.50	\$22.50
4	Bankrun Gravel	LF	\$2.50	\$2.50	\$4.80	\$4.80	\$4.80	\$4.80	\$9.60	\$9.60
5	Trench Safety	LF	\$3.50	\$3.50	\$3.50	\$3.50	\$3.50	\$10.00	\$10.00	\$10.00
6	Vertical Sawcut	LF	\$2.00	\$2.00	\$2.00	\$2.00	\$2.00	\$2.00	\$2.00	\$2.00
7	Crushed Surfacing, Base Course	LF	\$5.67	\$6.00	\$7.00	\$8.00	\$9.00	\$10.71	\$12.60	\$14.50
8	Asphalt Concrete, Class B	LF	\$15.05	\$15.69	\$17.63	\$19.57	\$21.51	\$25.37	\$29.24	\$33.11
	TOTAL INSTALLED PIPE COST	LF	\$60.22	\$71.69	\$92.43	\$111.87	\$131.81	\$235.88	\$310.94	\$394.71

Note: Some pipe costs have been modified in the project sheets to reflect difficult construction.

	Table 9.2-2 Catch Basin Costs		
Item	Description of Item	Unit	Cost
1	Catch Basin, Type I with Grate	Each	\$950.00
2	Catch Basin, Type II 48" Diameter	Each	\$2,400.00
3	Catch Basin, Type II, 54" Diameter	Each	\$2,900.00
4	Catch Basin, Type II, 60" Diameter	Each	\$3,500.00
5	Catch Basin, Type II, 72" Diameter	Each	\$4,000.00
6	Catch Basin, Type II, 96" Diameter	Each	\$8,000.00

#### 9.2.1 Capital Improvement Projects

# PROJECT C1

PROJECT NAME

North Miller Drainage Improvements

PROJECT EXHIBIT 9.2-1

PROJECT TYPE Conveyance

PROJECT LOCATION North Miller Street south to Maple Street

**PROJECT DESCRIPTION** The existing collection system in North Miller consists of

corrugated metal pipe (CMP) that is undersized for the proposed rerouting of flows in the collection system. Problems due to the age of the pipe are also beginning to develop. Internal inspections of the pipe have shown corrosion along the bottom of the pipe. Upgrades to the pipe will consist of replacing the pipe and a crossing under the Burlington Northern Santa Fe (BNSF) tracks. This will involve working directly adjacent to the regional

water main, which is also within North Miller.

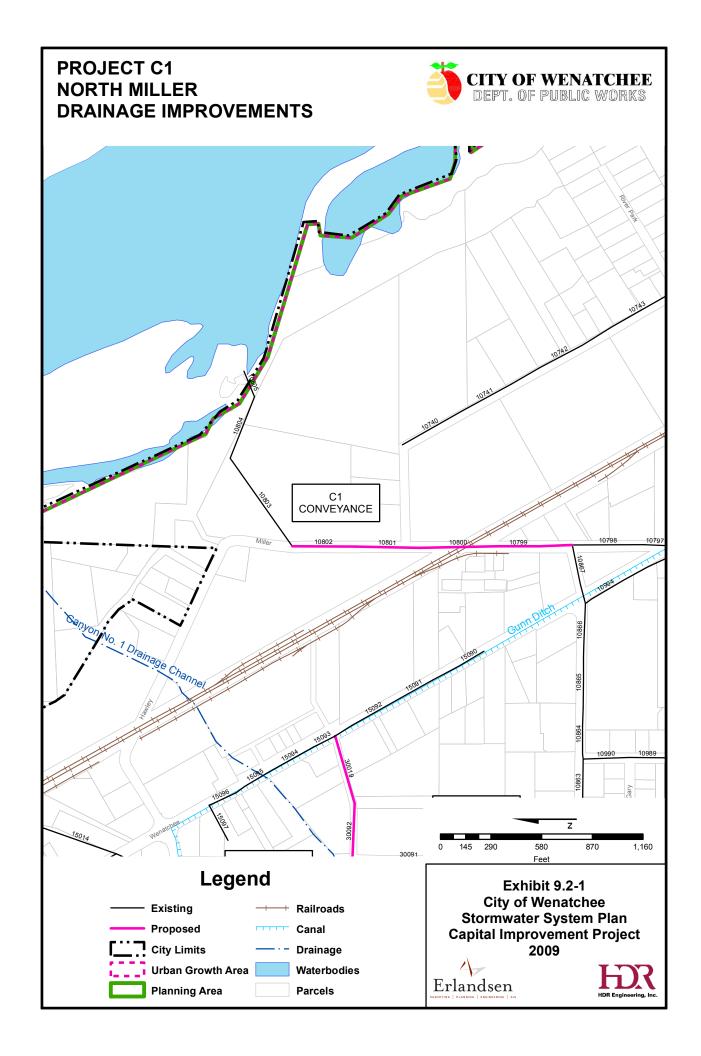
**ESTIMATED FLOWS** Flows are estimated around 200 cfs for a 10-year event.

**ESTIMATED** 

PROJECT COST (2009) \$1,430,000
CITY FUNDING 100%
COUNTY FUNDING 0%
PRIVATE FUNDING 0%

ESTIMATED TIME FRAME

**FOR COMPLETION** 5- to 10-Year Term



# PROJECT C2

PROJECT NAME

North Wenatchee Avenue/Duncan Drainage

Improvements

PROJECT EXHIBIT 9.2-2

PROJECT TYPE Conveyance

PROJECT LOCATION North Wenatchee Avenue and Duncan Road Area

**PROJECT DESCRIPTION** There is no collection system in North Wenatchee

Avenue directly south of the Wenatchee River Bridge. In addition, the collection system in Duncan Road is not continuous. The project will install a new system and will

replace the existing collection system to improve drainage and stormwater collection in the area.

**ESTIMATED FLOWS** Minimum flows for the drainage area (12-inch minimum

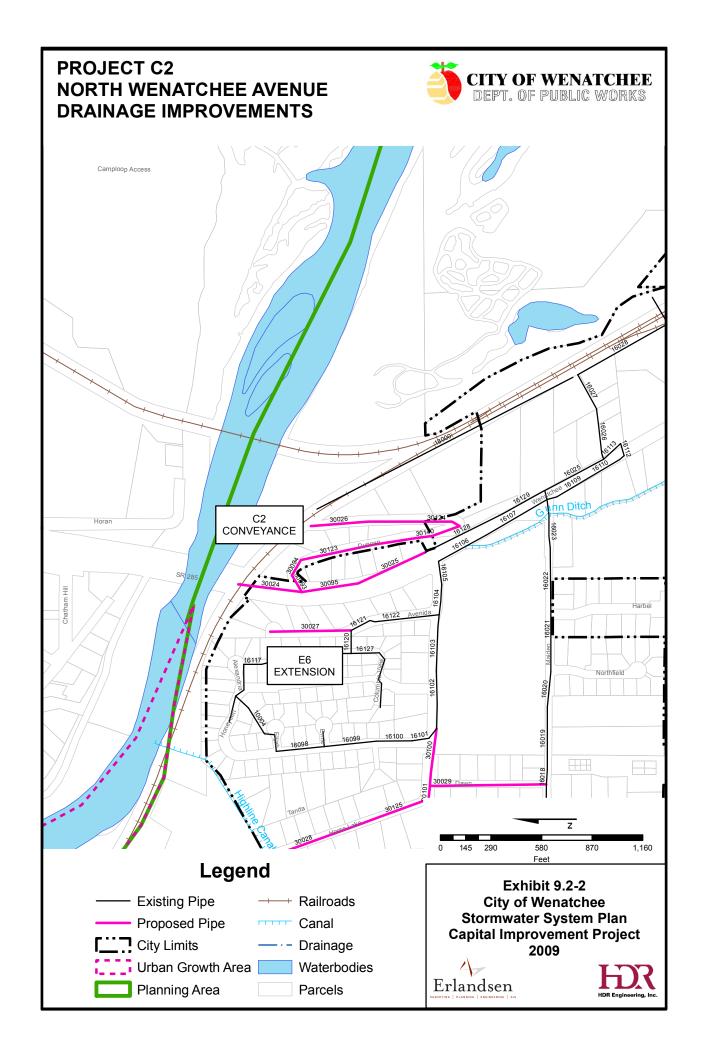
pipe).

**ESTIMATED** 

PROJECT COST (2009) \$344,500
CITY FUNDING 100%
COUNTY FUNDING 0%
PRIVATE FUNDING 0%

ESTIMATED TIME FRAME

**FOR COMPLETION** 5- to 10-Year Term



# **PROJECT C3**

**PROJECT NAME**Western Avenue Drainage Improvements

PROJECT EXHIBIT 9.2-3

PROJECT TYPE Conveyance

**PROJECT LOCATION** Western Avenue from Orchard Street south to No. 2

Canyon Road and west to Castle Heights Drive

**PROJECT DESCRIPTION** This project will remove the existing detention facilities for

Castle Rock Heights and route these flows to the improved conveyance system in Orchard Avenue. The existing collection system will be reconstructed along the alignment to redirect and handle the increased flows.

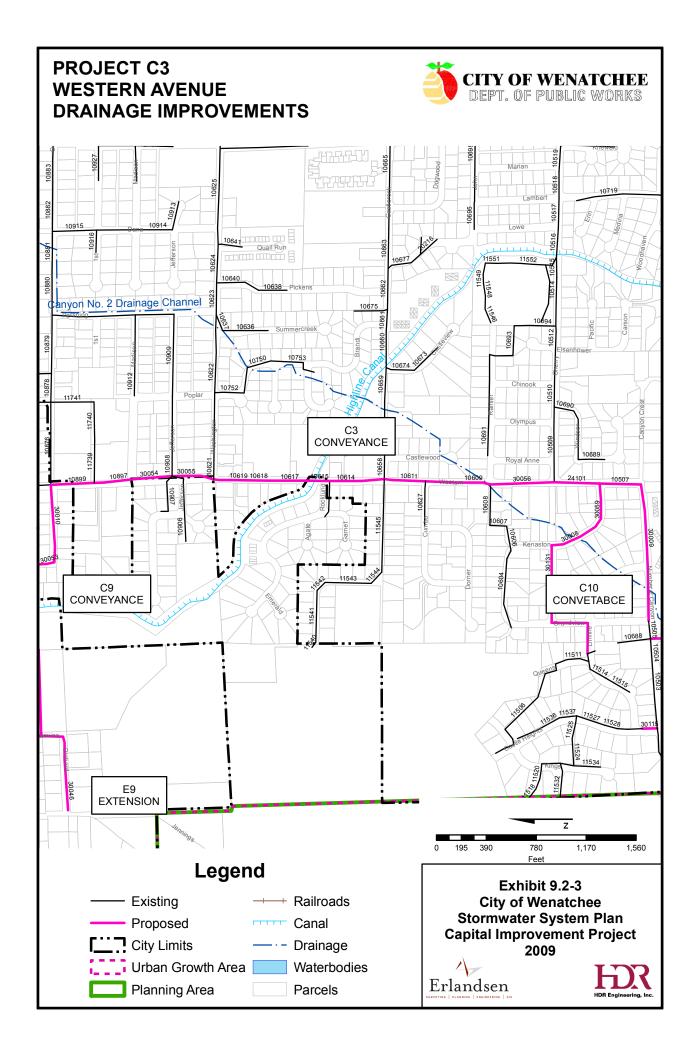
**ESTIMATED FLOWS** Flows are estimated at 10 cfs for a 10-year event.

**ESTIMATED** 

PROJECT COST (2009) \$590,000
CITY FUNDING 100%
COUNTY FUNDING 0%
PRIVATE FUNDING 0%

ESTIMATED TIME FRAME

**FOR COMPLETION** 5- to 10-Year Term



**PROJECT NAME** Pershing Drainage Improvements

PROJECT EXHIBIT 9.2-4

PROJECT TYPE Conveyance

**PROJECT LOCATION** Pershing Street from Maple to Springwater Avenue

**PROJECT DESCRIPTION** This project will add a collection system to separate the

Canyon No. 1 drainage flows from the urban collection system. The existing collection system will be modified to discharge flows into the existing Maple Street collection

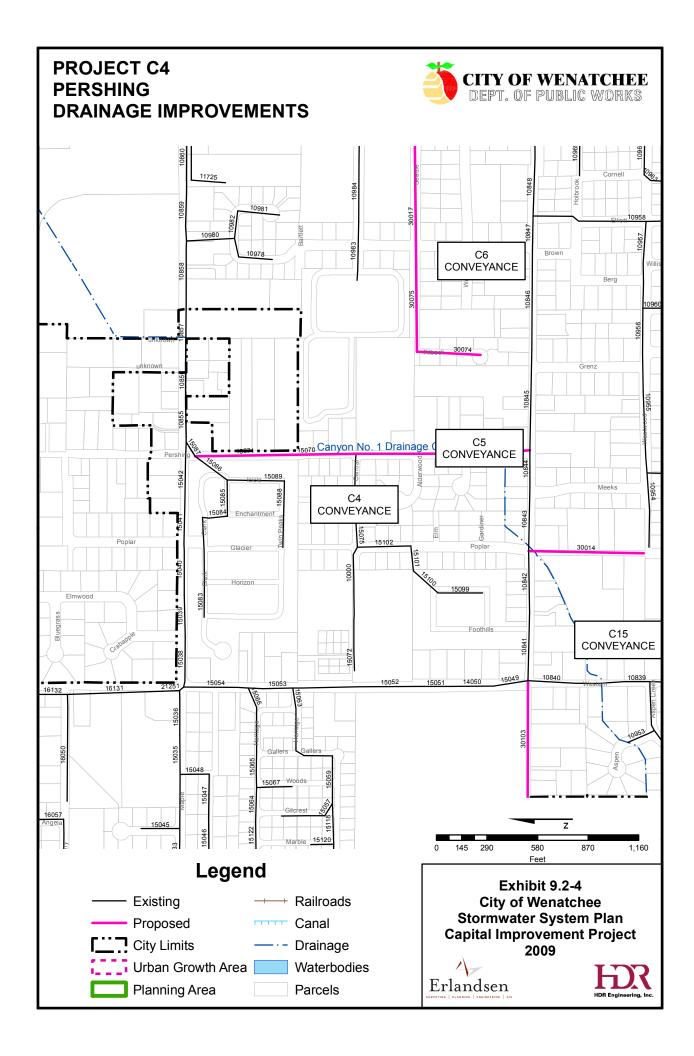
system.

**ESTIMATED FLOWS** Flows are estimated at 19.5 cfs for a 10-year event.

**ESTIMATED** 

PROJECT COST (2009) \$324,000
CITY FUNDING 100%
COUNTY FUNDING 0%
PRIVATE FUNDING 0%

ESTIMATED TIME FRAME



PROJECT NAME Filbeck Drainage Improvements

PROJECT EXHIBIT 9,2-5

PROJECT TYPE Conveyance

**PROJECT LOCATION** Filbeck Place in the vicinity of Lewis and Clark Park

**PROJECT DESCRIPTION** There is no collection or conveyance system in the

project area. This project will install a new collection system in the Filbeck Place area of Wenatchee.

Installation of catch basins will be included in the project.

**ESTIMATED FLOWS** Minimum flows for the drainage area (12-inch minimum

pipe).

**ESTIMATED** 

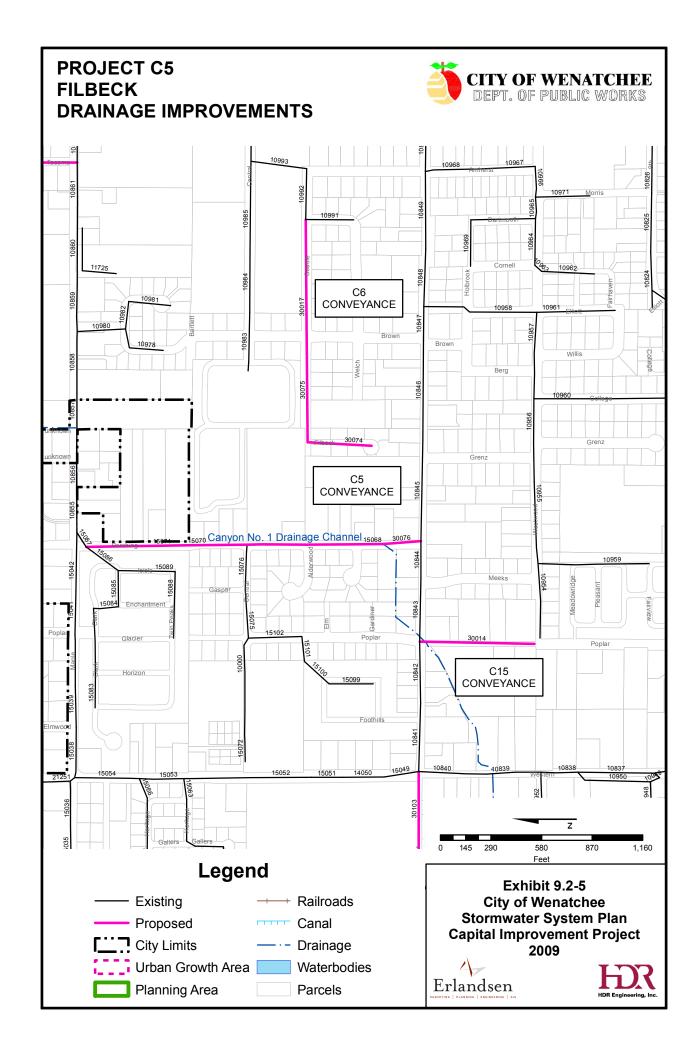
**PROJECT COST (2009)** \$50,000

CITY FUNDING 100%

COUNTY FUNDING 0%

PRIVATE FUNDING 0%

ESTIMATED TIME FRAME



PROJECT NAME Seattle Drainage Improvements

PROJECT EXHIBIT 9.2-6

PROJECT TYPE Conveyance

PROJECT LOCATION Seattle Street from Amherst to Filbeck

**PROJECT DESCRIPTION** There is no collection system in Seattle Street. The

project will install a new collection and conveyance

system to alleviate local drainage issues.

**ESTIMATED FLOWS** Minimum flows for the drainage area (12-inch minimum

pipe).

**ESTIMATED** 

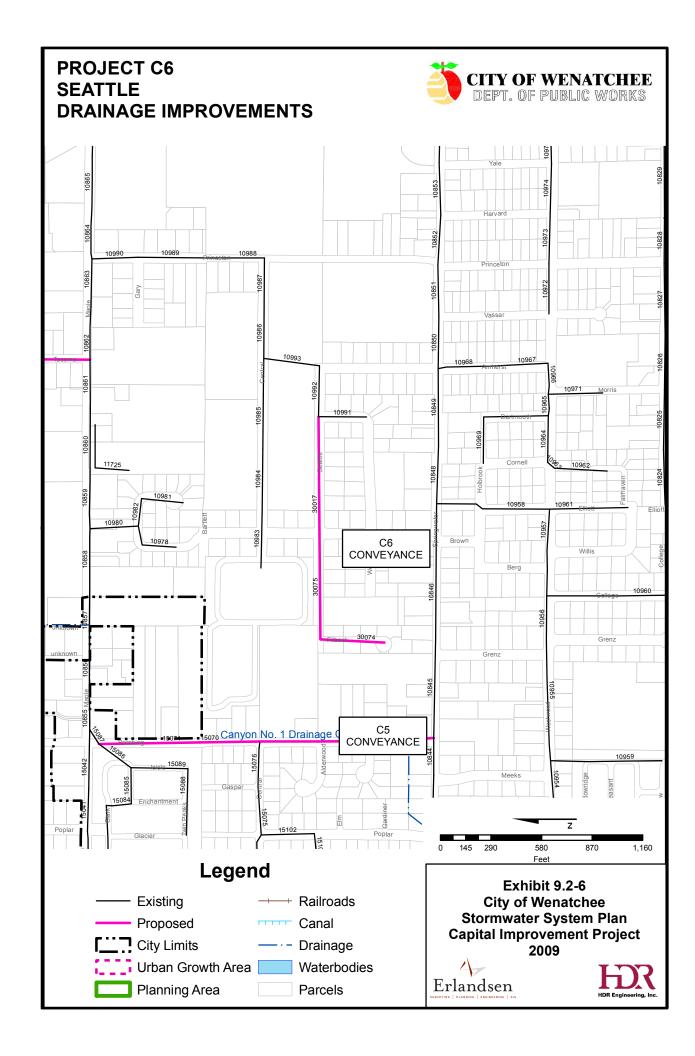
**PROJECT COST (2009)** \$163,500

CITY FUNDING 100%

COUNTY FUNDING 0%

PRIVATE FUNDING 0%

ESTIMATED TIME FRAME



**PROJECT NAME** Tacoma and Pine Drainage Improvements

PROJECT EXHIBIT 9.2-7

PROJECT TYPE Conveyance

PROJECT LOCATION Tacoma from McKittrick to Maple Street

Pine from Walnut to McKittrick

**PROJECT DESCRIPTION** There is no collection or conveyance system in the

project area. This project will install a new collection and conveyance system in both Tacoma and Pine Avenues. Installation of catch basins will be included in the project.

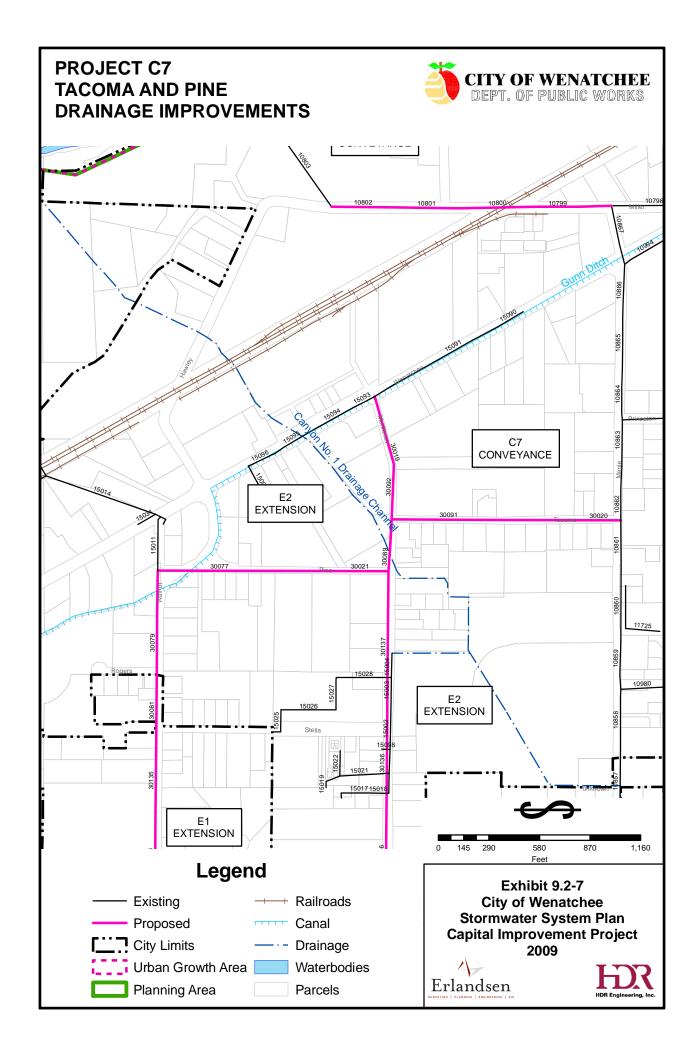
**ESTIMATED FLOWS** Flows are estimated between 4.0 and 19.5 cfs for a 10-

year event.

**ESTIMATED** 

PROJECT COST (2009) \$172,800
CITY FUNDING 100%
COUNTY FUNDING 0%
PRIVATE FUNDING 0%

ESTIMATED TIME FRAME



PROJECT NAME Ramona and Sunset Drainage Improvements

PROJECT EXHIBIT 9.2-8

PROJECT TYPE Conveyance

PROJECT LOCATION Ramona and Sunset Avenues from Ninth Street to Fifth

Street

**PROJECT DESCRIPTION** There is no collection or conveyance system in the

project area. This project will install a new collection and

conveyance system in both Ramona and Sunset Avenues. Installation of catch basins will be included in

the project.

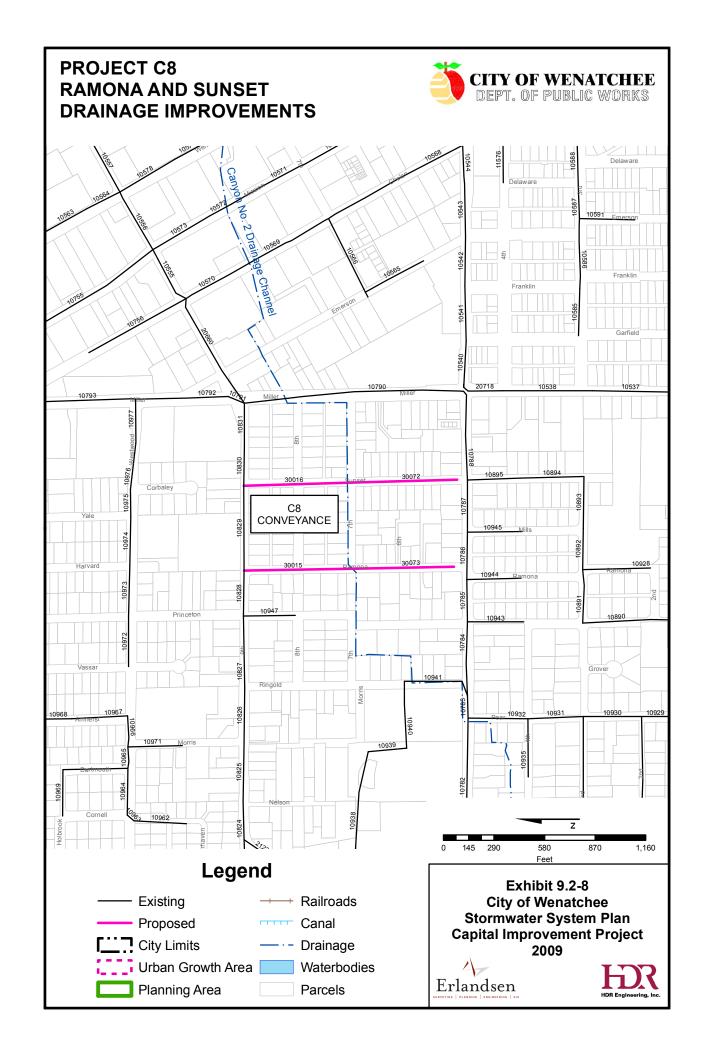
**ESTIMATED FLOWS** Minimum flows for the drainage area (12-inch minimum

pipe).

**ESTIMATED** 

PROJECT COST (2009) \$314,000
CITY FUNDING 100%
COUNTY FUNDING 0%
PRIVATE FUNDING 0%

ESTIMATED TIME FRAME



**PROJECT NAME** Orchard Drainage Improvements

PROJECT EXHIBIT 9.2-9

PROJECT TYPE Conveyance

PROJECT LOCATION Orchard Street from Western heading west to Second

Street

**PROJECT DESCRIPTION** There is no collection or conveyance system in the

project area. This project will install a new collection and conveyance system in Orchard Avenue. Installation of

catch basins will be included in the project.

**ESTIMATED FLOWS** Minimum flows for the drainage area (12-inch minimum

pipe).

**ESTIMATED** 

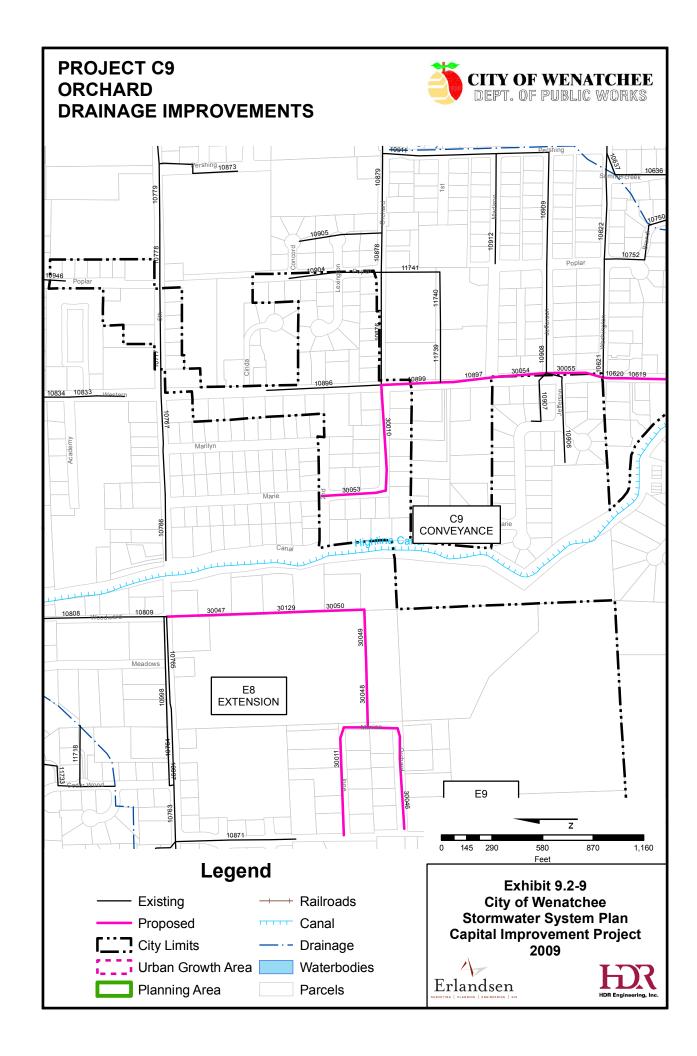
**PROJECT COST (2009)** \$128,500

CITY FUNDING 50%

COUNTY FUNDING 50%

PRIVATE FUNDING 0%

ESTIMATED TIME FRAME



**PROJECT NAME**Kenaston and Linville Drainage Improvements

PROJECT EXHIBIT 9.2-10

PROJECT TYPE Conveyance

PROJECT LOCATION Sections of Kenaston Drive, Wellington Place, Grandview

Avenue, and Linville between Western and Castle Rock

Heights

**PROJECT DESCRIPTION** There is no collection or conveyance system in the

project area. This project will install a new collection and conveyance system in the local area. Installation of catch

basins will be included in the project.

**ESTIMATED FLOWS** Minimum flows for the drainage area (12-inch minimum

pipe).

**ESTIMATED** 

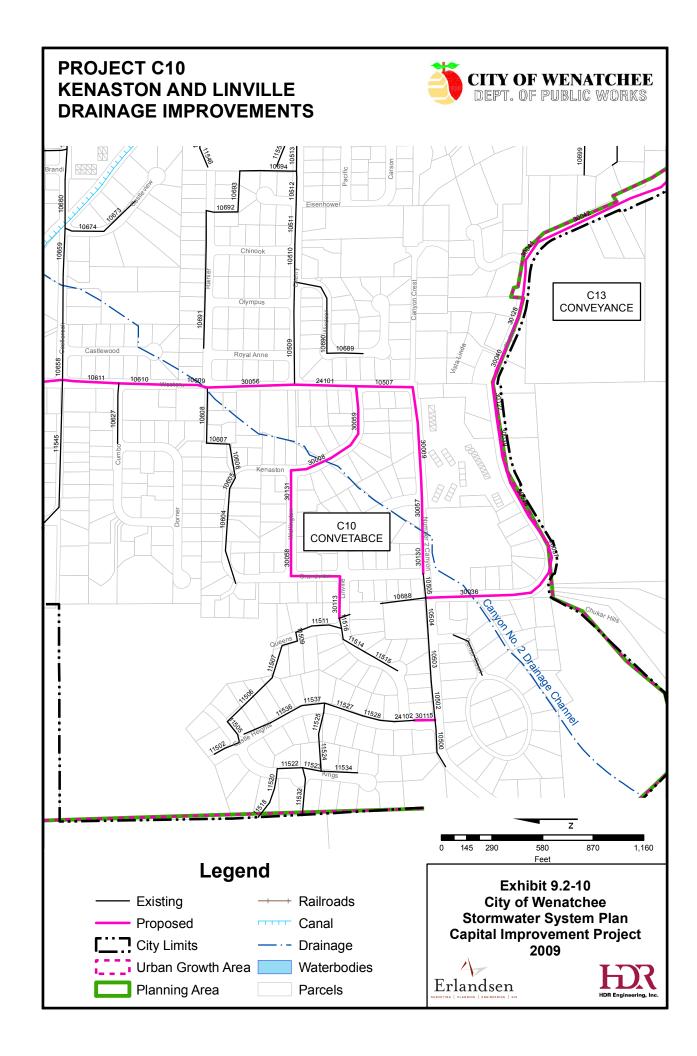
**PROJECT COST (2009)** \$239,500

CITY FUNDING 100%

COUNTY FUNDING 0%

PRIVATE FUNDING 0%

**ESTIMATED TIME FRAME** 



**PROJECT NAME** Marr and Margo Drainage Improvements

PROJECT EXHIBIT 9.2-11

PROJECT TYPE Conveyance

PROJECT LOCATION Marr and Marjo Streets between Mission and Methow

Streets

**PROJECT DESCRIPTION** There is no collection or conveyance system in the

project area. This project will install a new collection and conveyance system in the local area. Installation of catch

basins will be included in the project.

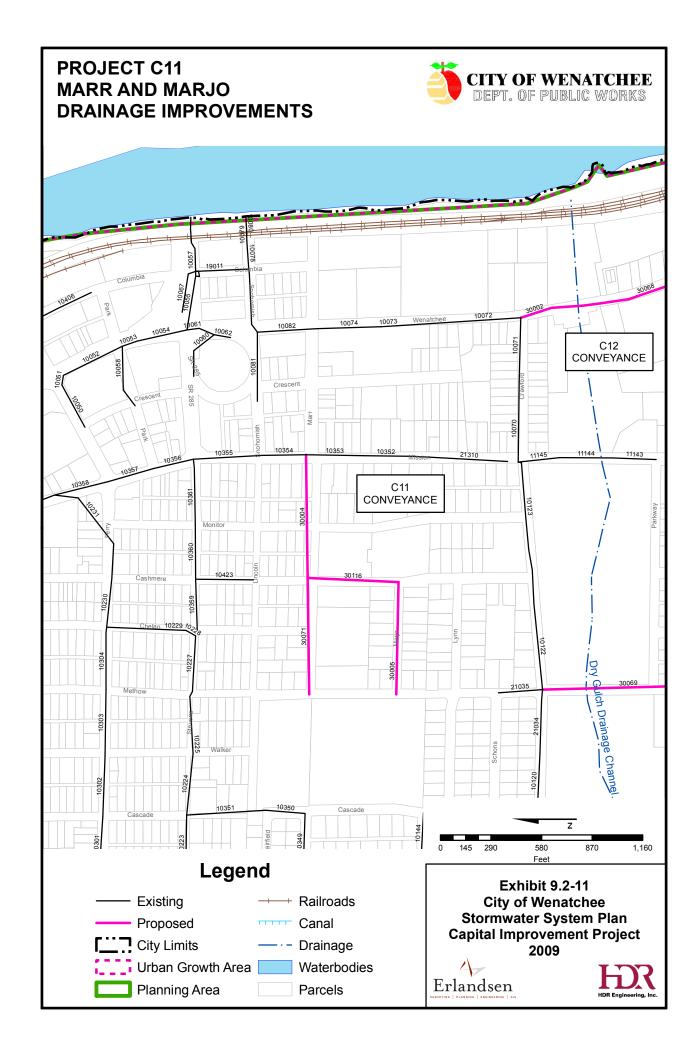
**ESTIMATED FLOWS** Minimum flows for the drainage area (12-inch minimum

pipe).

**ESTIMATED** 

PROJECT COST (2009) \$325,500
CITY FUNDING 100%
COUNTY FUNDING 0%
PRIVATE FUNDING 0%

ESTIMATED TIME FRAME



**PROJECT NAME**South Wenatchee Drainage Improvements

PROJECT EXHIBIT 9.2-12

PROJECT TYPE Conveyance

**PROJECT LOCATION**South Wenatchee Avenue between Crawford and

Viewdale Drive

**PROJECT DESCRIPTION** There is no collection or conveyance system in the

project area. This project will install a new collection and conveyance system in the South Wenatchee Avenue. Installation of catch basins will be included in the project.

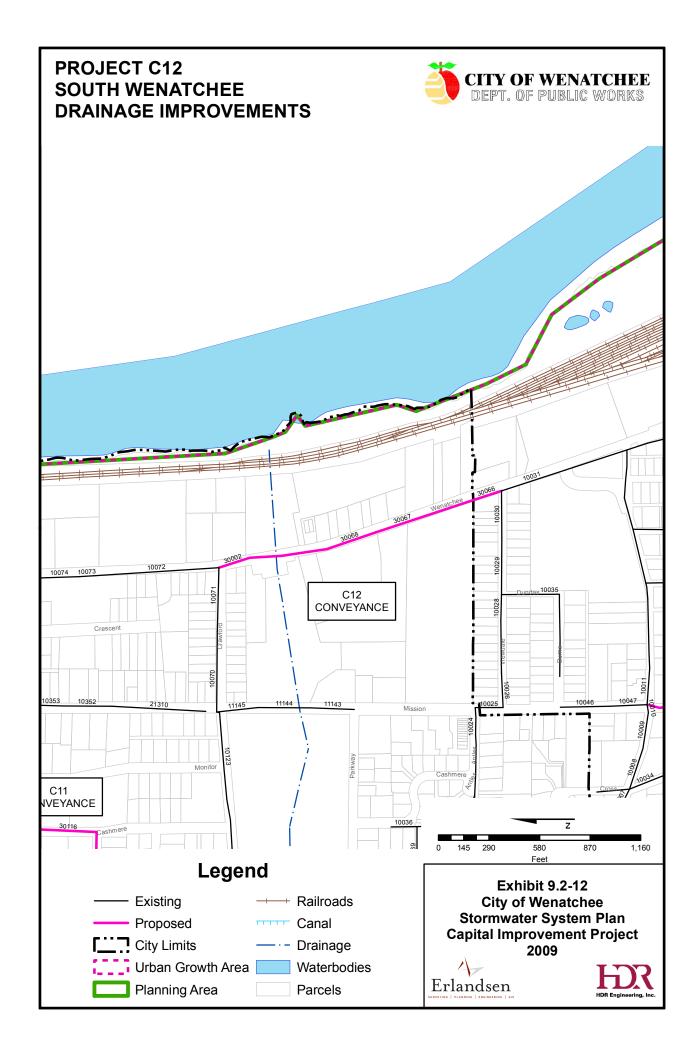
**ESTIMATED FLOWS** Minimum flows for the drainage area (12-inch minimum

pipe).

**ESTIMATED** 

PROJECT COST (2009) \$221,500
CITY FUNDING 100%
COUNTY FUNDING 0%
PRIVATE FUNDING 0%

ESTIMATED TIME FRAME



**PROJECT NAME** Skyline Drive Drainage Improvements

PROJECT EXHIBIT 9.2-13

PROJECT TYPE Conveyance

**PROJECT LOCATION** Skyline Drive from No. 2 Canyon to Red Apple Road

**PROJECT DESCRIPTION** There is no collection or conveyance system in the

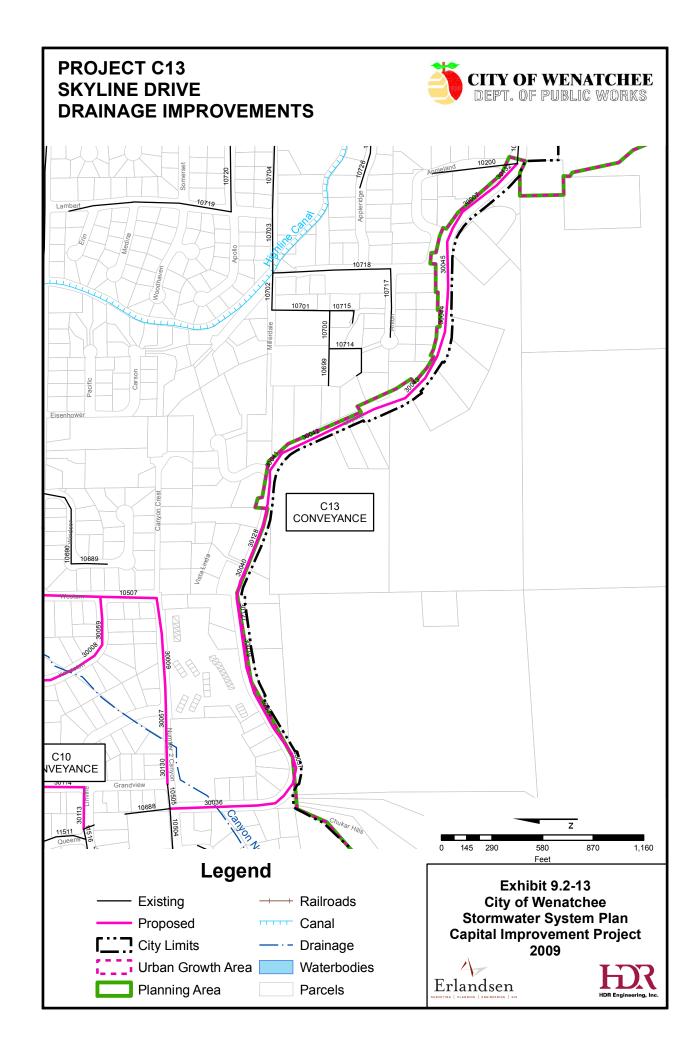
project area. This project will install a new collection and conveyance system in Skyline Drive. Installation of catch basins will be included in the project. Private property nearby will need to detain post-developed runoff so that discharge rates are limited to pre-developed rates.

**ESTIMATED FLOWS** Flows are estimated at 2.6 cfs for a 10-year event.

**ESTIMATED** 

PROJECT COST (2009) \$696,000
CITY FUNDING 50%
COUNTY FUNDING 50%
PRIVATE FUNDING 0%

ESTIMATED TIME FRAME



PROJECT NAME

Horse Lake Road Drainage Improvements

PROJECT EXHIBIT 9.2-14

PROJECT TYPE Conveyance

PROJECT LOCATION Horse Lake Road from the city limits to Honeysett Road

**PROJECT DESCRIPTION** There is no collection or conveyance system in the

project area. This project will install a new collection and conveyance system in Horse Lake Road. Installation of

catch basins will be included in the project.

**ESTIMATED FLOWS** Minimum flows for the drainage area (12-inch minimum

pipe).

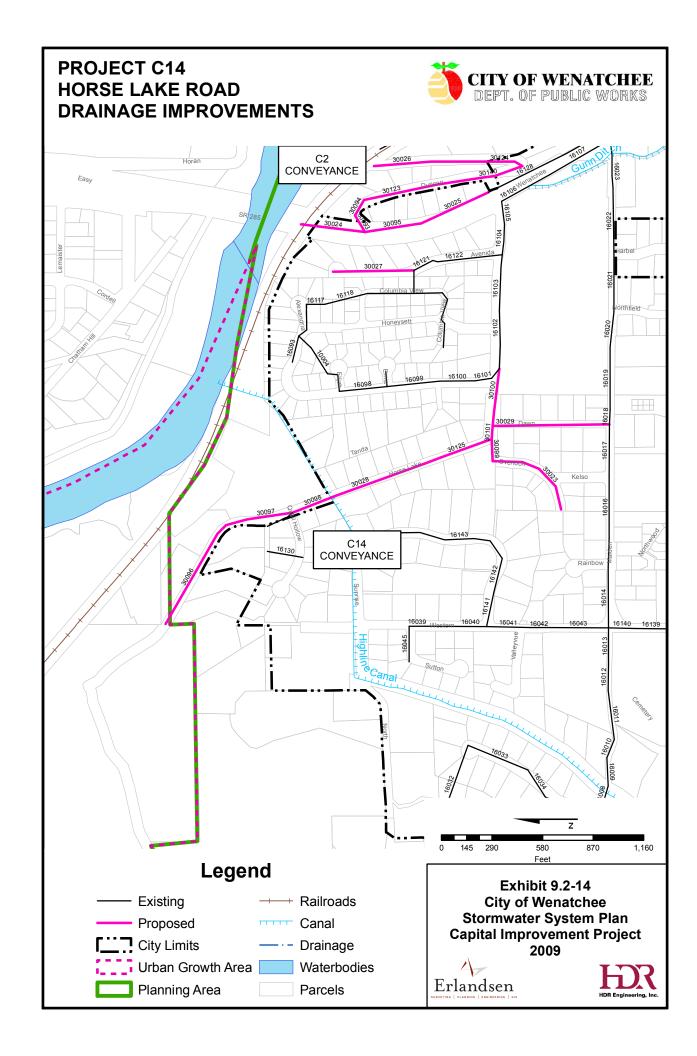
**ESTIMATED** 

**PROJECT COST (2009)** \$521,900 **CITY FUNDING** 80%

COUNTY FUNDING 20%

PRIVATE FUNDING 0%

ESTIMATED TIME FRAME



PROJECT NAME Poplar Drainage Improvements

PROJECT EXHIBIT 9.2-15

PROJECT TYPE Conveyance

**PROJECT LOCATION** Poplar Avenue from Springwater to Westwood Avenues

**PROJECT DESCRIPTION** There is no collection or conveyance system in the

project area. This project will install a new collection and conveyance system in Poplar Avenue. Installation of

catch basins will be included in the project.

**ESTIMATED FLOWS** Minimum flows for the drainage area (12-inch minimum

pipe).

**ESTIMATED** 

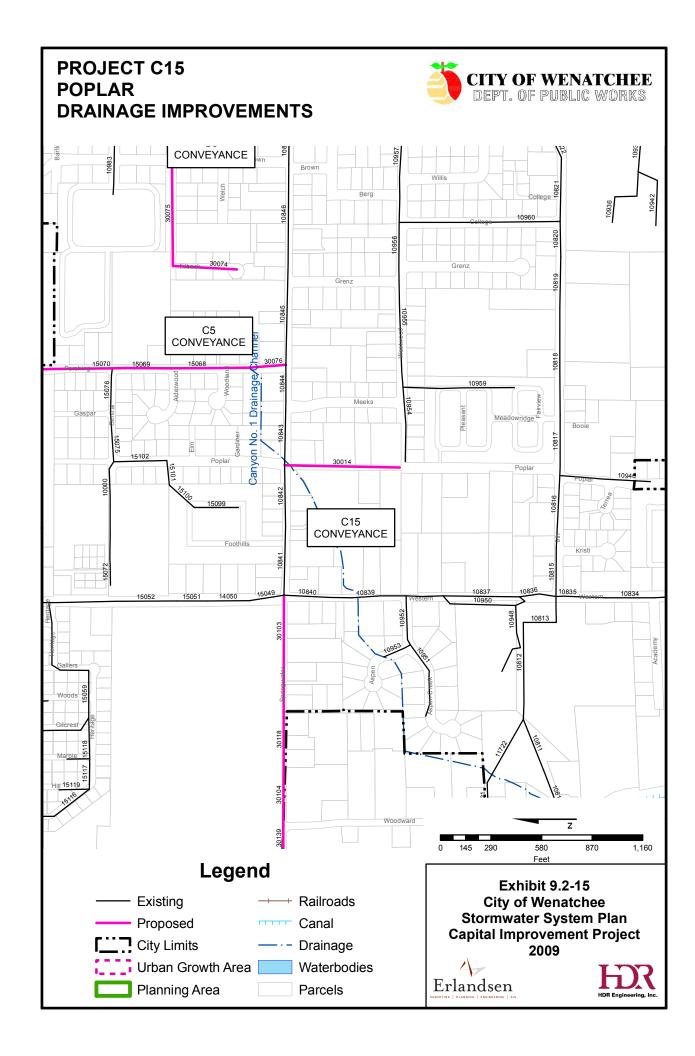
**PROJECT COST (2009)** \$84,000

CITY FUNDING 100%

COUNTY FUNDING 0%

PRIVATE FUNDING 0%

ESTIMATED TIME FRAME



**PROJECT NAME**Methow Drainage Improvements

PROJECT EXHIBIT 9.2-16

PROJECT TYPE Conveyance

PROJECT LOCATION Methow Street from Crawford to Ridgeview Drive

**PROJECT DESCRIPTION** There is no collection or conveyance system in the

project area. This project will install a new collection and conveyance system in Methow Avenue. Installation of

catch basins will be included in the project.

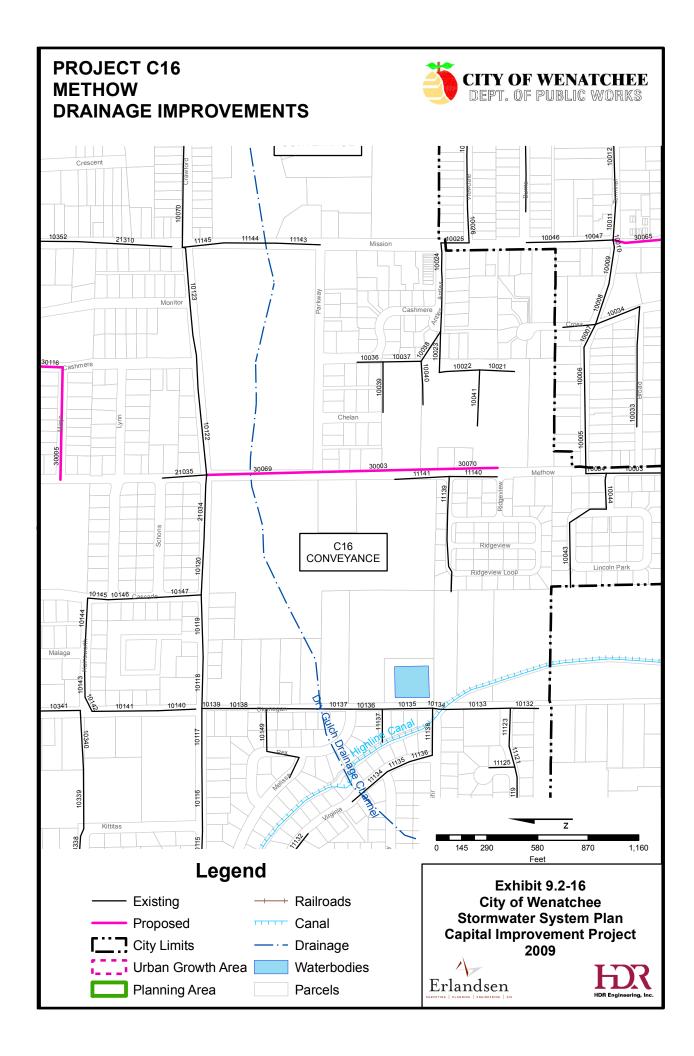
**ESTIMATED FLOWS** Minimum flows for the drainage area (12-inch minimum

pipe).

**ESTIMATED** 

PROJECT COST (2009) \$219,600
CITY FUNDING 100%
COUNTY FUNDING 0%
PRIVATE FUNDING 0%

ESTIMATED TIME FRAME



**PROJECT NAME** Day Road Drainage Improvements

PROJECT EXHIBIT 9.2-17

PROJECT TYPE Conveyance

**PROJECT LOCATION** Day and Lester Roads

**PROJECT DESCRIPTION** There is no collection or conveyance system in the

project area. This project will install a new collection and conveyance system in the Day and Lester Road area. Installation of catch basins will be included in the project.

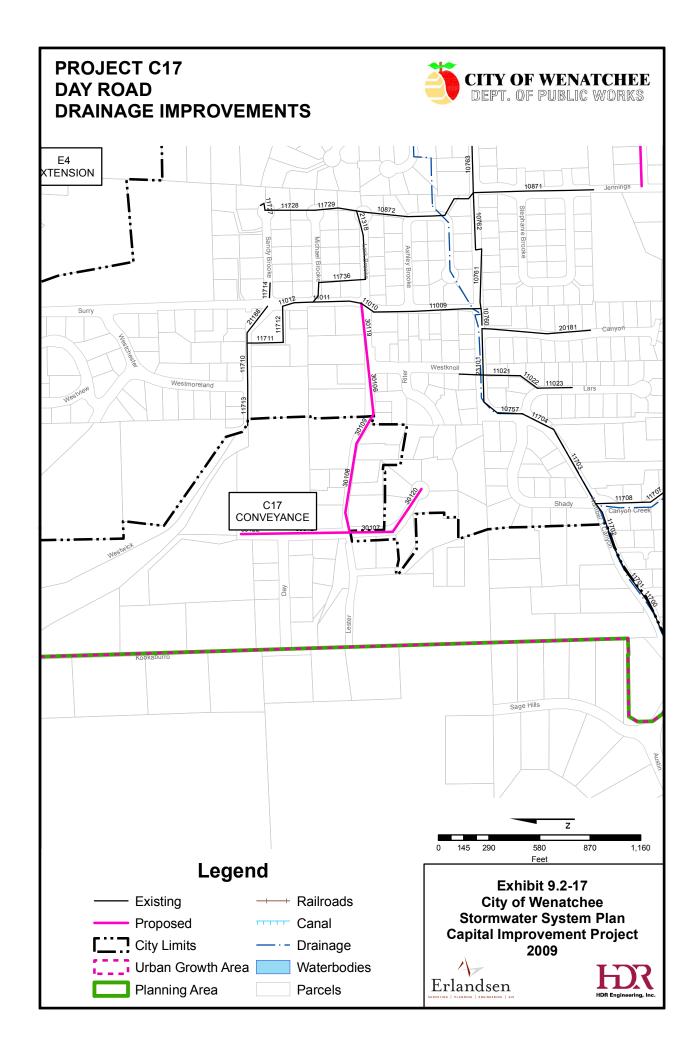
**ESTIMATED FLOWS** Minimum flows for the drainage area (12-inch minimum

pipe).

**ESTIMATED** 

PROJECT COST (2009) \$323,500
CITY FUNDING 40%
COUNTY FUNDING 60%
PRIVATE FUNDING 0%

ESTIMATED TIME FRAME



PROJECT NAME

North Wenatchee Stormwater Facility Improvements

PROJECT EXHIBIT 9.2-18

PROJECT TYPE Conveyance

**PROJECT LOCATION** Area East of North Wenatchee Avenue near BNSF

**Tracks** 

**PROJECT DESCRIPTION** The existing collection system in the area directly south of

the Wenatchee River discharges into an open ditch that is located adjacent to the BNSF railway tracks. This open conveyance system is located in the BNSF right of way and as such maintenance to the system is difficult to complete with limited access and the difficulty in obtaining the required permits. The project entails replacing the open ditch with a closed piping system. This system will allow maintenance to be completed with a jet truck gaining access through existing manhole structures. All flows drain to a 24-inch diameter culvert under the BNSF

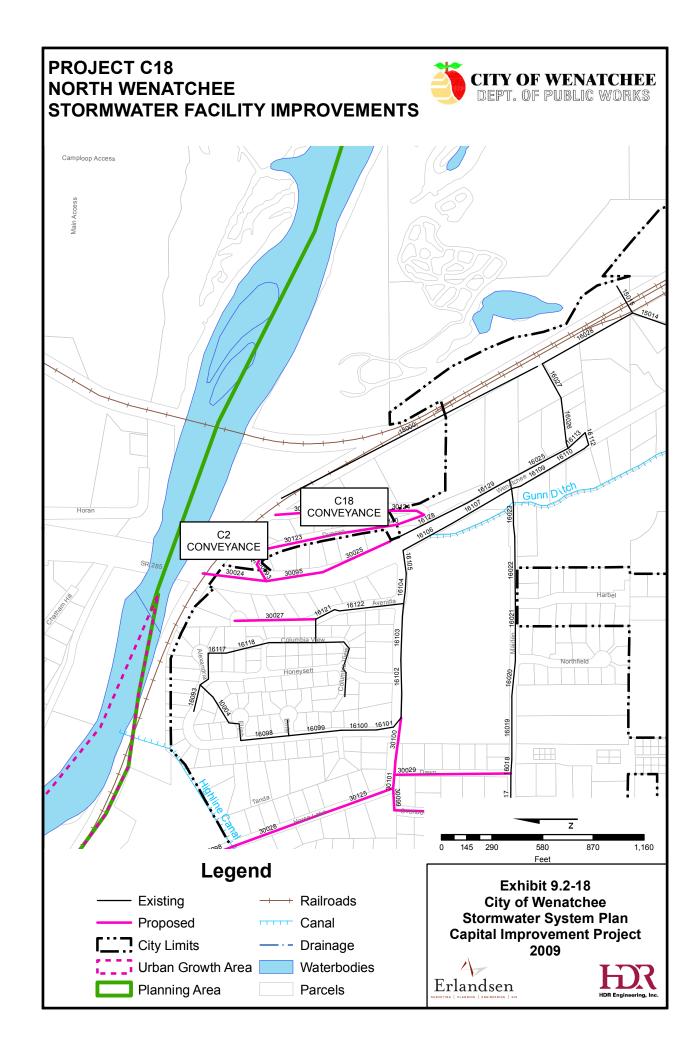
tracks.

**ESTIMATED FLOWS** Flows are estimated around 33 cfs for a 10-year event.

**ESTIMATED** 

PROJECT COST (2009) \$100,000
CITY FUNDING 100%
COUNTY FUNDING 0%
PRIVATE FUNDING 0%

ESTIMATED TIME FRAME



#### PROJECT E1

PROJECT NAME Walnut Drainage Extension

PROJECT EXHIBIT 9.2-19

PROJECT TYPE Extension

PROJECT LOCATION Walnut Street from Wenatchee Avenue to Western Street

**PROJECT DESCRIPTION** There is no collection or conveyance system in the

project area. This project will install a new collection and conveyance system in Walnut Street. Installation of catch

basins will be included in the project.

**ESTIMATED FLOWS** Flows are estimated between 4 and 17 cfs for a 10-year

event.

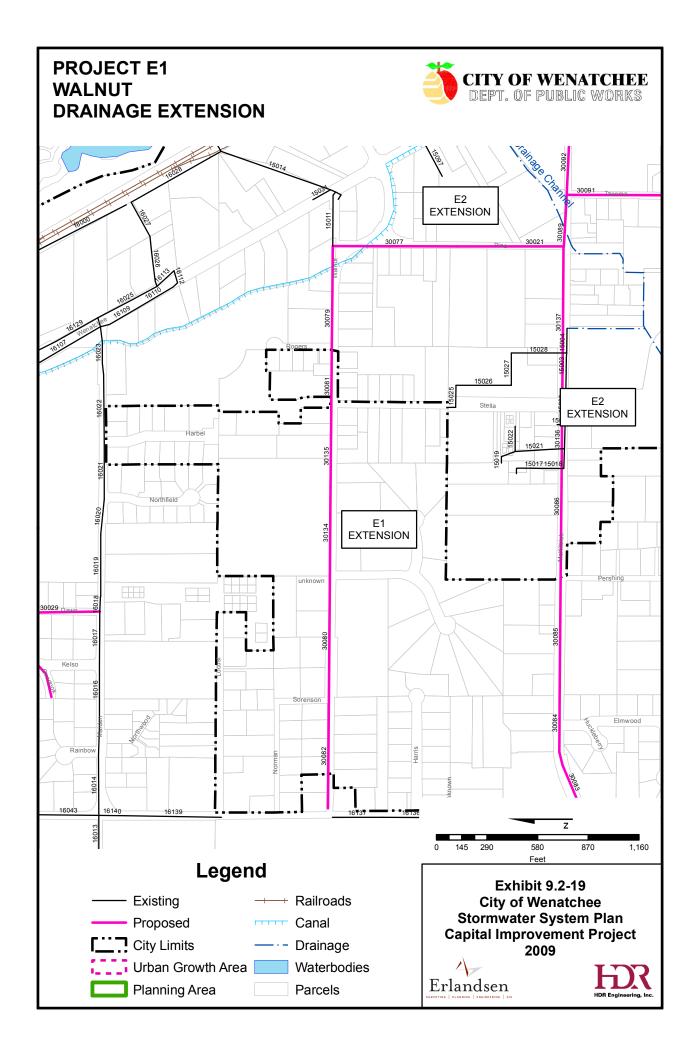
**ESTIMATED** 

**PROJECT COST (2009)** \$448,000 **CITY FUNDING** 20%

COUNTY FUNDING 60%

PRIVATE FUNDING 20%

ESTIMATED TIME FRAME



#### **PROJECT E2**

PROJECT NAME McKittrick Drainage Extension

PROJECT EXHIBIT 9.2-20

PROJECT TYPE Extension

PROJECT LOCATION McKittrick Street Wenatchee Avenue to Western Avenue

**PROJECT DESCRIPTION** There is no collection or conveyance system in the

project area. This project will install a new collection and conveyance system in McKittrick Street. Installation of

catch basins will be included in the project.

**ESTIMATED FLOWS** Flows are estimated between 4 and 16 cfs for a 10-year

event.

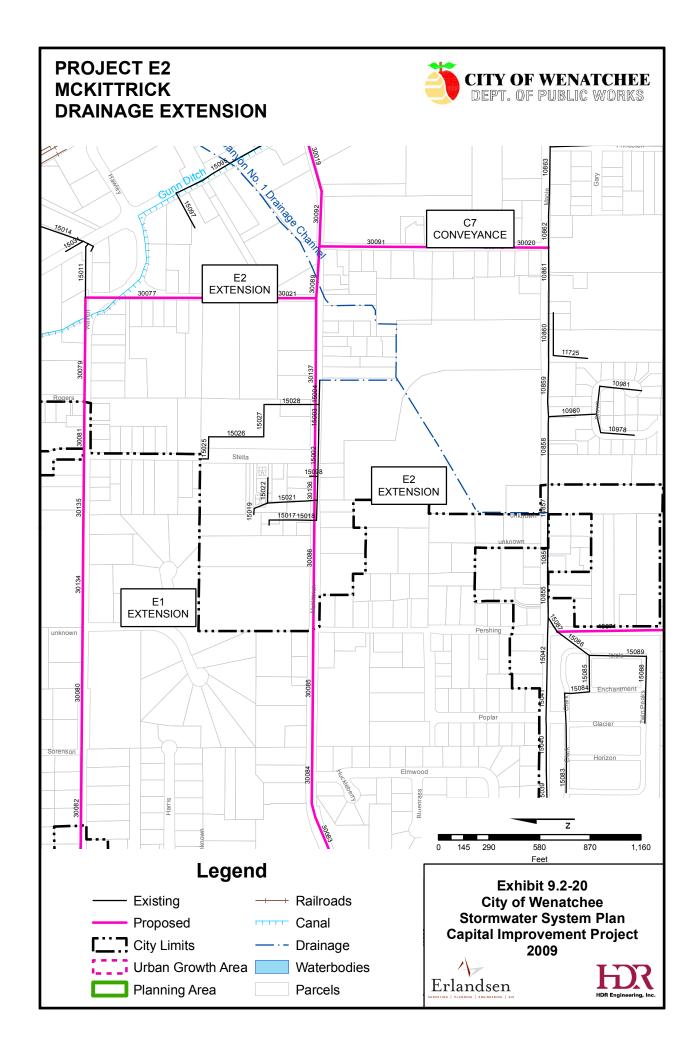
**ESTIMATED** 

**PROJECT COST (2009)** \$844,000 **CITY FUNDING** 20%

COUNTY FUNDING 60%

PRIVATE FUNDING 20%

ESTIMATED TIME FRAME



#### **PROJECT E3**

PROJECT NAME Maple Street Drainage Extension

PROJECT EXHIBIT 9.2-21

PROJECT TYPE Extension

**PROJECT LOCATION**Maple Street from Benroy Avenue to the Canal

**PROJECT DESCRIPTION** There is no collection or conveyance system in the

project area. This project will install a new collection and conveyance system in Maple Street. Installation of catch

basins will be included in the project.

**ESTIMATED FLOWS** Minimum flows for the drainage area (12-inch minimum

pipe).

**ESTIMATED** 

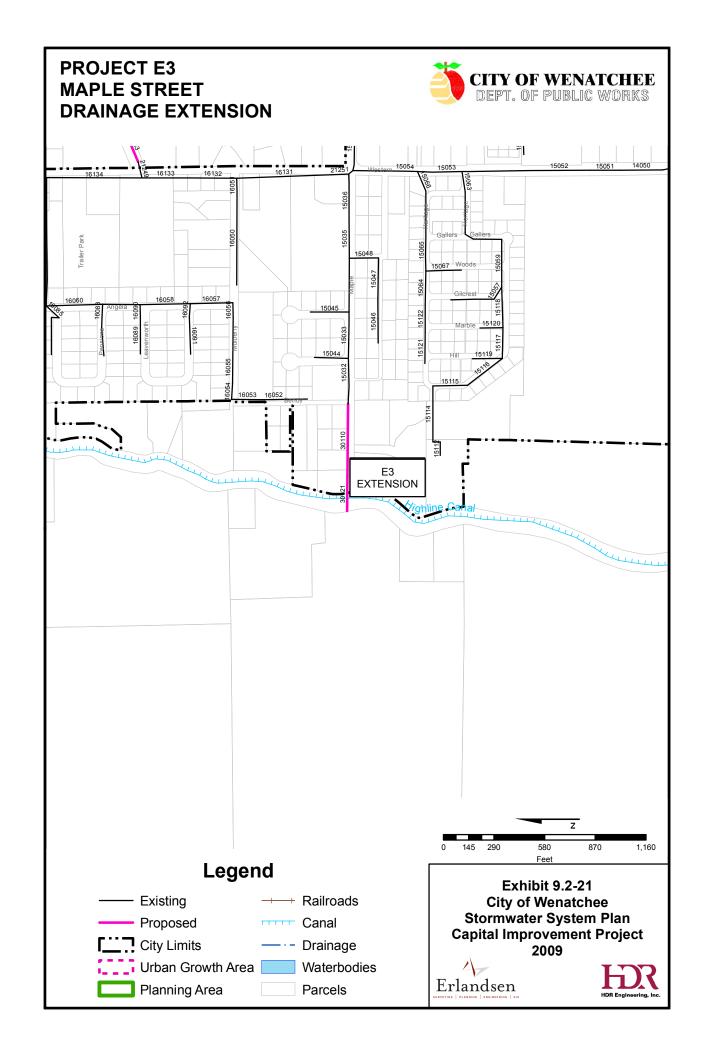
**PROJECT COST (2009)** \$79,500

CITY FUNDING 80%

COUNTY FUNDING 10%

PRIVATE FUNDING 10%

ESTIMATED TIME FRAME



**PROJECT NAME** Springwater Drainage Extension

PROJECT EXHIBIT 9.2-22

PROJECT TYPE Extension

**PROJECT LOCATION** Springwater Street from Western Avenue to Canal

**PROJECT DESCRIPTION** There is no collection or conveyance system in the

project area. This project will install a new collection and conveyance system in Springwater Street. Installation of

catch basins will be included in the project.

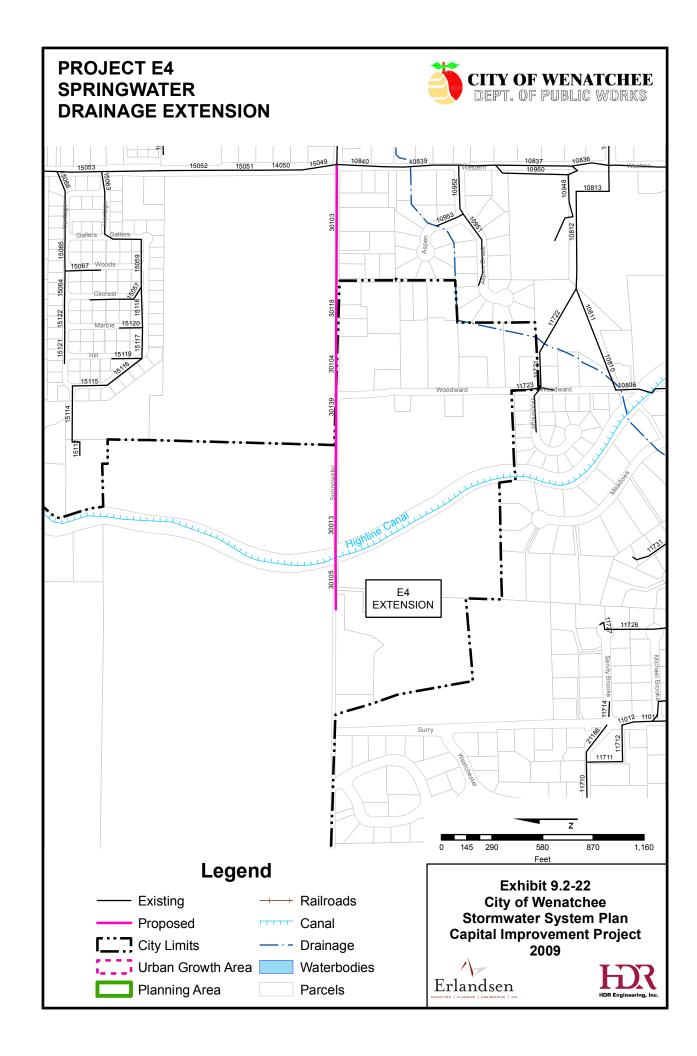
**ESTIMATED FLOWS** Minimum flows for the drainage area (12-inch minimum

pipe).

**ESTIMATED** 

PROJECT COST (2009) \$330,000
CITY FUNDING 30%
COUNTY FUNDING 30%
PRIVATE FUNDING 40%

ESTIMATED TIME FRAME



**PROJECT NAME** South Hills Drive Drainage Extension

PROJECT EXHIBIT 9.2-23

PROJECT TYPE Extension

**PROJECT LOCATION**South Hills Drive from Red Apple Road to Crawford

Avenue

**PROJECT DESCRIPTION** There is no collection or conveyance system in the

project area. This project will install a new collection and conveyance system in South Hills Drive. Installation of catch basins will be included in the project. Private property nearby will need to detain post-developed runoff so that discharge rates are limited to pre-developed rates.

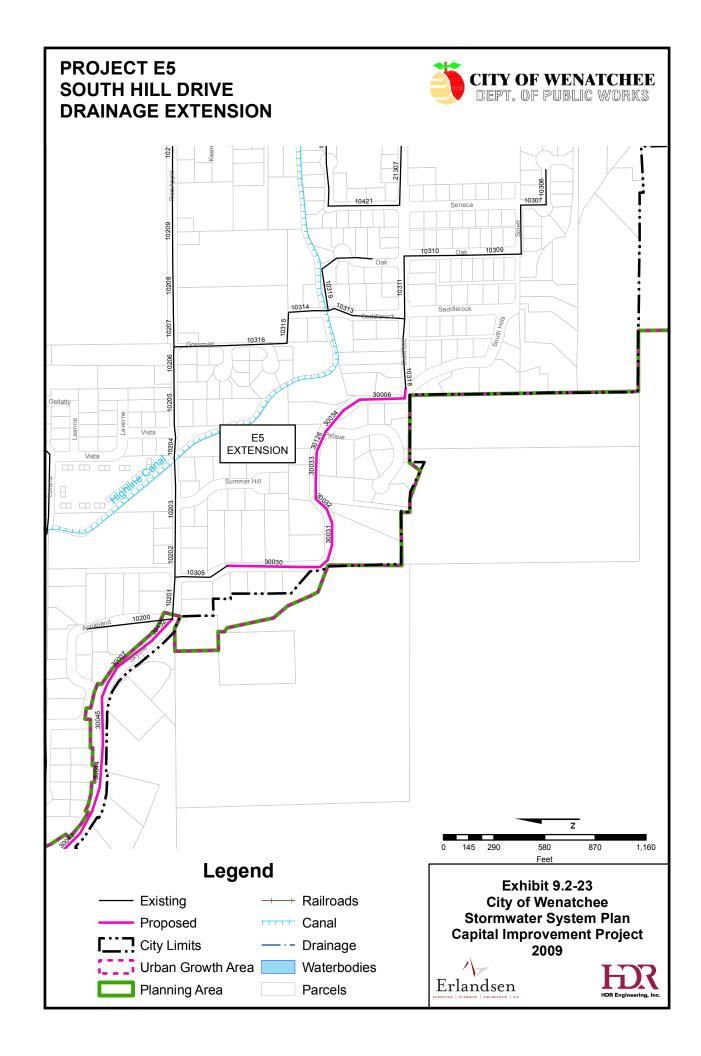
**ESTIMATED FLOWS** Minimum flows for the drainage area (12-inch minimum

pipe).

**ESTIMATED** 

PROJECT COST (2009) \$237,500
CITY FUNDING 90%
COUNTY FUNDING 10%
PRIVATE FUNDING 0%

ESTIMATED TIME FRAME



PROJECT NAME Avenida Drainage Extension

PROJECT EXHIBIT 9.2-24

PROJECT TYPE Extension

**PROJECT LOCATION** Avenida Way from midpoint to Wenatchee River

**PROJECT DESCRIPTION** There is no collection or conveyance system in the

project area. This project will install a new collection and conveyance system in Avenida Way. Installation of catch

basins will be included in the project.

**ESTIMATED FLOWS** Minimum flows for the drainage area (12-inch minimum

pipe).

**ESTIMATED** 

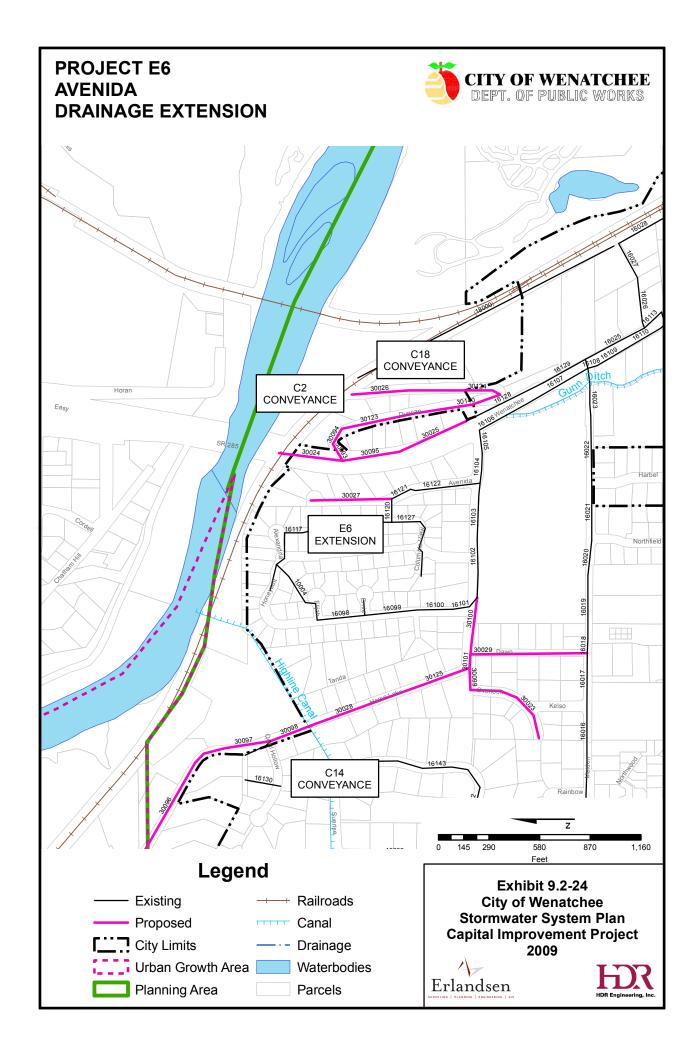
**PROJECT COST (2009)** \$63,500

CITY FUNDING 100%

COUNTY FUNDING 0%

PRIVATE FUNDING 0%

ESTIMATED TIME FRAME



PROJECT NAME Squilchuck Drainage Extension

PROJECT EXHIBIT 9.2-25

PROJECT TYPE Extension

**PROJECT LOCATION** Squilchuck Road from Terminal Avenue to city limits

**PROJECT DESCRIPTION** There is no collection or conveyance system in the

project area. This project will install a new collection and conveyance system in Squilchuck Road. Installation of

catch basins will be included in the project.

**ESTIMATED FLOWS** Flows are estimated between 0.4 and 16.2 cfs for a 10-

year event.

**ESTIMATED** 

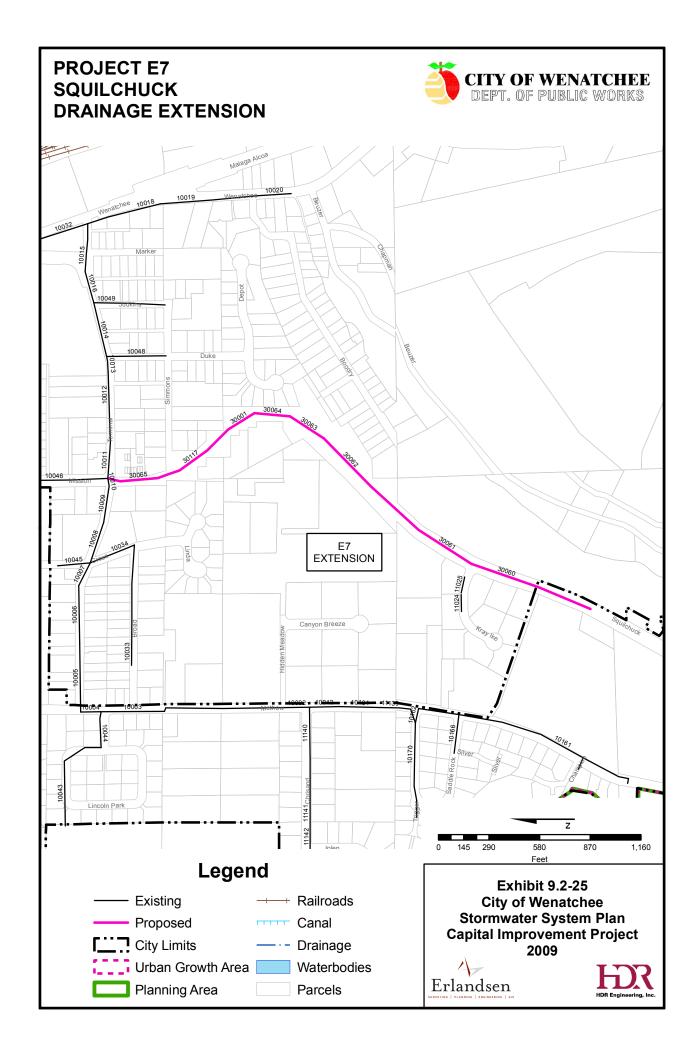
**PROJECT COST (2009)** \$454,000

CITY FUNDING 80%

COUNTY FUNDING 20%

PRIVATE FUNDING 0%

ESTIMATED TIME FRAME



PROJECT NAME

Jennings Drainage Extension

PROJECT EXHIBIT 9.2-26

PROJECT TYPE Extension

**PROJECT LOCATION**Jennings Street to Woodward Drive

**PROJECT DESCRIPTION** There is no collection or conveyance system in the

project area. This project will install a new collection and conveyance system to serve the Jennings Street area. Installation of catch basins will be included in the project.

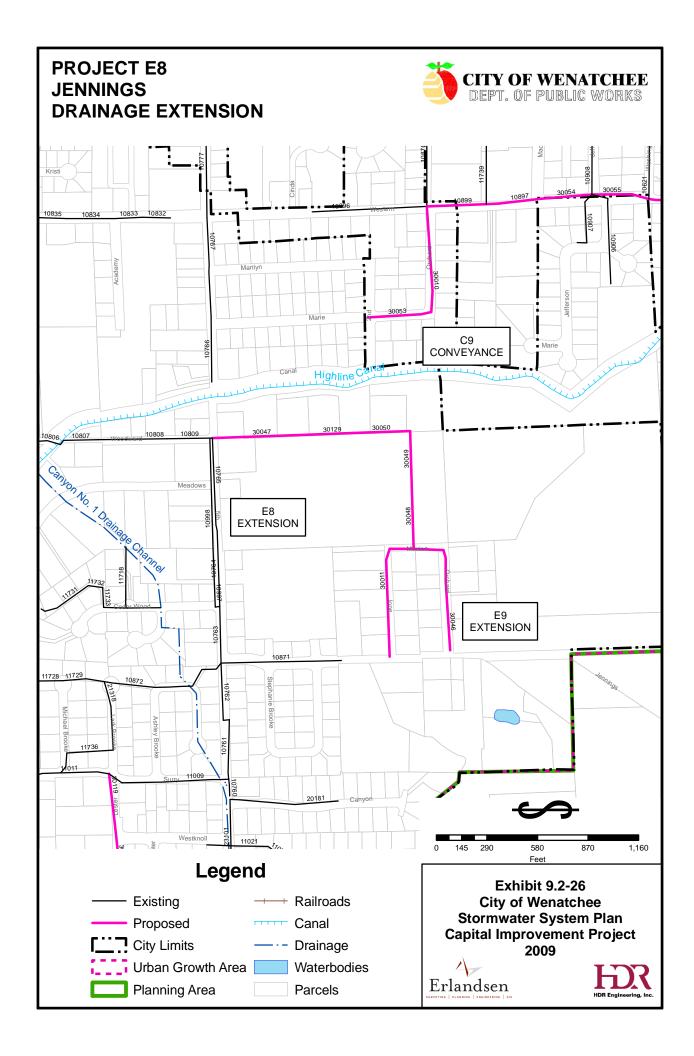
**ESTIMATED FLOWS** Minimum flows for the drainage area (12-inch minimum

pipe).

**ESTIMATED** 

PROJECT COST (2009) \$149,000
CITY FUNDING 0%
COUNTY FUNDING 0%
PRIVATE FUNDING 100%

ESTIMATED TIME FRAME



**PROJECT NAME** Ione and Maxine Drainage Extension

PROJECT EXHIBIT 9.2-27

PROJECT TYPE Extension

**PROJECT LOCATION** Ione Street and Maxine Avenue area

**PROJECT DESCRIPTION** There is no collection or conveyance system in the

project area. This project will install a new collection and conveyance system in Ione Street and Maxine Avenue area. Installation of catch basins will be included in the

project.

**ESTIMATED FLOWS** Minimum flows for the drainage area (12-inch minimum

pipe).

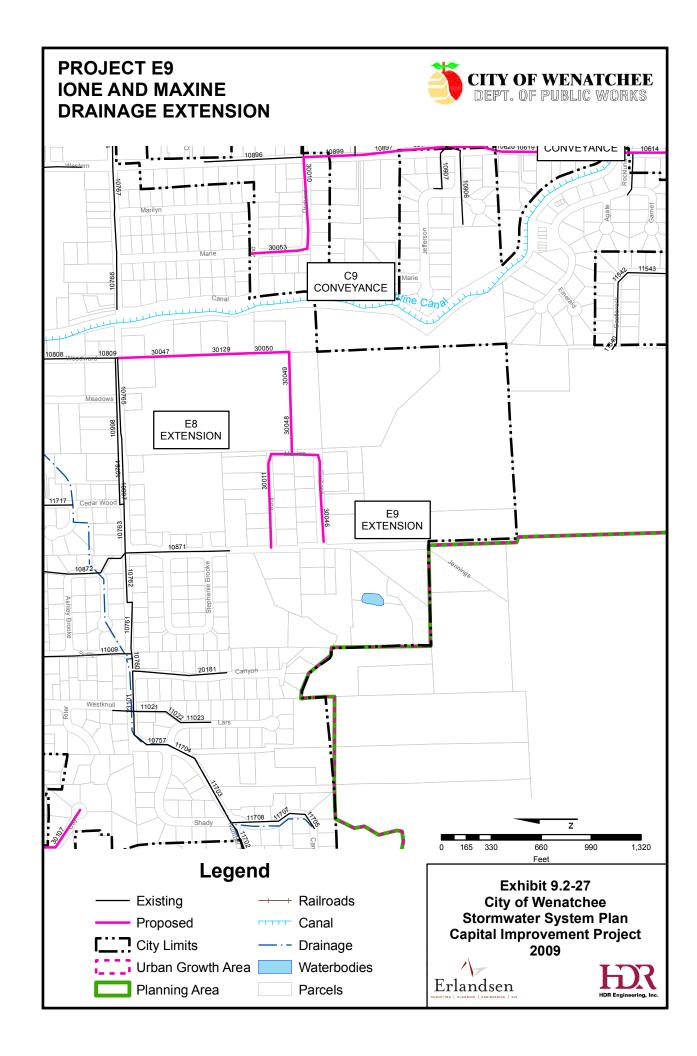
**ESTIMATED** 

**PROJECT COST (2009)** \$285,000 **CITY FUNDING** 90%

COUNTY FUNDING 10%

PRIVATE FUNDING 0%

ESTIMATED TIME FRAME



## **PROJECT WQ1**

**PROJECT NAME** Snow Melt Water Quality Facility

PROJECT EXHIBIT 9.2-28

PROJECT TYPE Water Quality

PROJECT LOCATION Worthern Street

**PROJECT DESCRIPTION** The Snow Melt Facility provides an area to dispose of

snow removed from roads in Wenatchee. A temporary facility is located near Wenatchee's Waste Water

Treatment Plant (WWTP) Facility on Worthern Street and will provide area to dispose of snow and improve water quality at the same time. The plan is to use wastewater flows to melt snow and then introduce this melted snow into the WWTP. At this time, the project is still in a pilot

stage and is being evaluated by the City and Ecology

staff.

**ESTIMATED** 

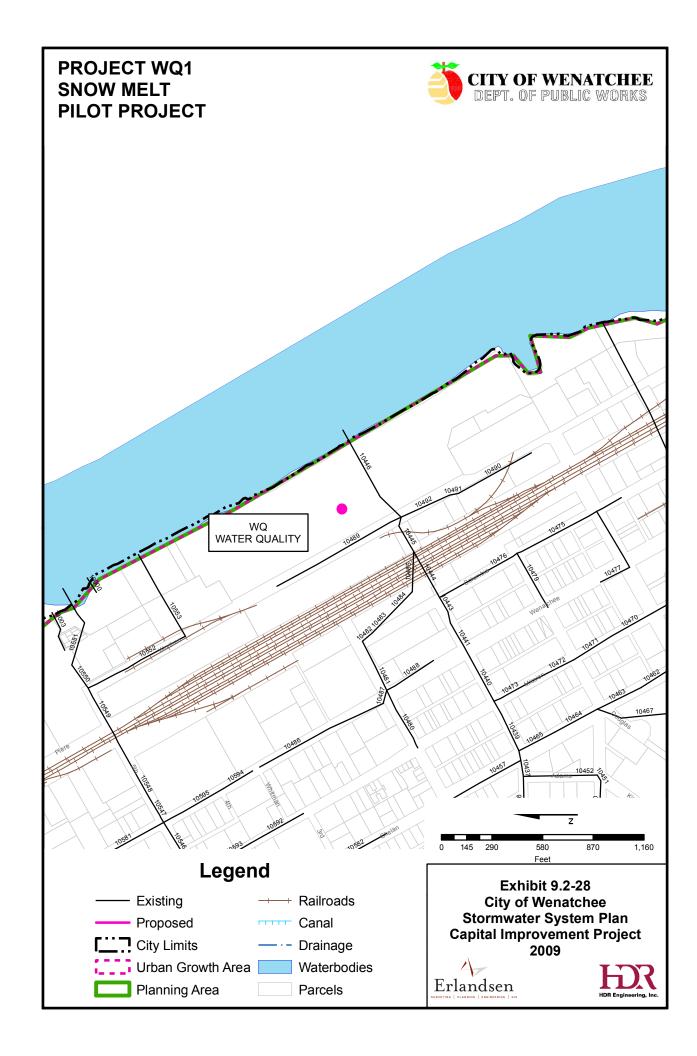
PROJECT COST (2009) \$300,000 City Design Memorandum

CITY FUNDING 100%

COUNTY FUNDING 0%

PRIVATE FUNDING 0%

ESTIMATED TIME FRAME



## **PROJECT WQ2**

PROJECT NAME

Linden Tree Phase II Facility Improvements

PROJECT EXHIBIT 9.2-29

PROJECT TYPE Water Quality

PROJECT LOCATION Linden Tree discharge area north of the Ninth Street –

Walla Walla Avenue Intersection

**PROJECT DESCRIPTION** Phase I of the project has already been completed.

Phase I work consisted of improvements to the existing

stormwater pond. Phase II work will complete

construction of the overflow bypass system as designed by Anchor Environmental. The high flow bypass system consists of a new 48-inch diameter pipe and outfall that

discharges into the Columbia River.

**ESTIMATED FLOWS** System design flows vary between 25 and 100 cfs.

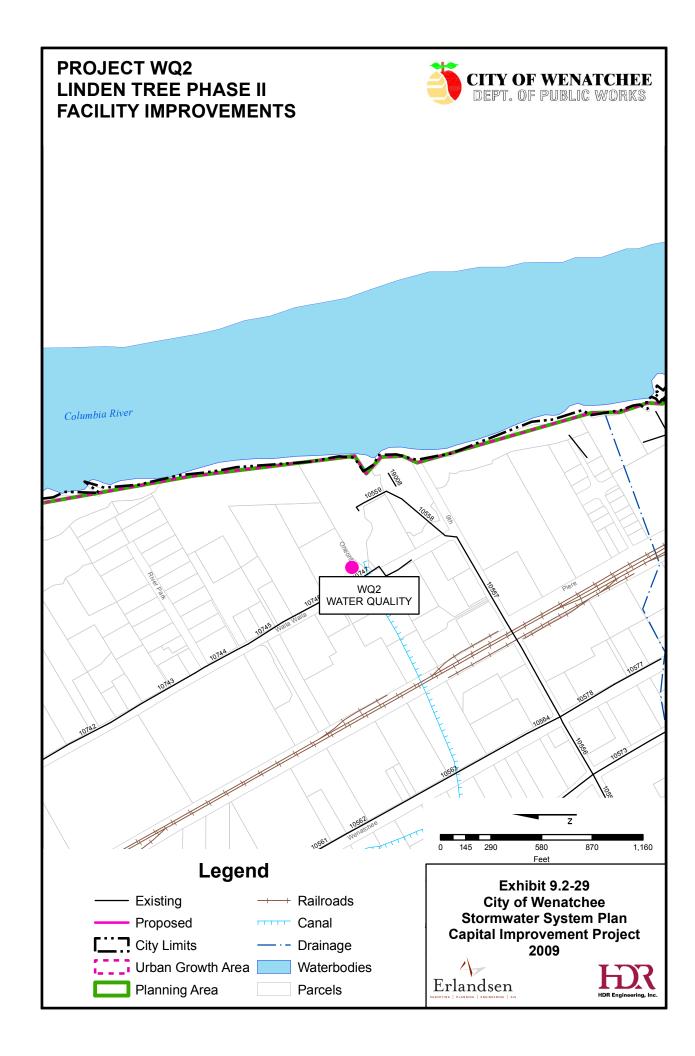
**ESTIMATED** 

PROJECT COST (2009) \$250,000
CITY FUNDING 100%
COUNTY FUNDING 0%
PRIVATE FUNDING 0%

ESTIMATED TIME FRAME

**FOR COMPLETION** 0- to 2-Year Term

Estimate of construction costs based upon design work estimate provided by the City.



## **PROJECT WQ3**

PROJECT NAME Decant Facility

PROJECT EXHIBIT No Location Proposed

PROJECT TYPE Water Quality

**PROJECT LOCATION**The proposed regional location will be somewhere in the

Wenatchee Valley

**PROJECT DESCRIPTION** This project consists of the development of a decant

facility designed to facilitate the processing of water and solids collected from storm manholes and catch basins. The facility will dewater the solids, which will ultimately be transferred to the regional landfill. Water will be treated and discharged into the natural environment. The facility proposed at this time will be regional providing a

discharge point for the City, the Washington State Department of Transportation (WSDOT), East

Wenatchee, Chelan County, and Douglas County. At this time there is no proposed location or definitive project

cost. A budgetary amount is provided.

ESTIMATED FLOWS Not Applicable

**ESTIMATED** 

**PROJECT COST (2009)** \$500,000

CITY FUNDING 50%
COUNTY FUNDING 50%

PRIVATE FUNDING 0%

ESTIMATED TIME FRAME

## 9.2.2 Summary of Capital Improvement Projects

Table 9.2-3 provides the costs of the capital improvement projects over the 2010 to 2019 period escalated at 4 percent per year. Sources of funding to complete the projects available to the City are described in Section 9.4. Exhibit 9.2-30 shows the location of the projects.

#### 9.3 Financial Plan

The City will be conducting a rate study as a follow-on to this Stormwater Plan. The rate study will include developing a financial plan to address operations and capital funding needs based on the CIP in this Plan. Any necessary rate adjustments will also be identified.

## 9.4 Capital Funding Sources

This section describes the primary capital funding sources available through the State to support implementing the capital plan.

#### 9.4.1 Public Works Trust Fund Loans

The Public Works Trust Fund (PWTF) was established by the state legislature in 1985 to provide a dependable, long-term source of funds to local governments for repairing and reconstructing their public works systems. Funds are administered by the Washington State Department of Commerce (formerly the Department of Community Trade and Economic Development).

When available, this program includes emergency loans, capital facilities planning loans, pre-construction design loans, and construction loans. Loans are made for repairing, replacing, or reconstructing existing public works systems to meet current standards and to adequately serve the needs of existing populations first, although the fund has also been available to serve growth scenarios.

In order to qualify for Trust Fund loans, Cities, Towns, and Counties must be imposing the full 1/4 percent local real estate excise tax. Also, a jurisdiction must have in place a local long-term plan for financing its public works needs and/or must be in compliance with GMA.

For the 2009–2011 biennium, the legislature has not funded the loan program for the Construction, Pre-Construction, or Planning categories. However, the loan program might become available again in the future; therefore, current information about these loans is presented in Table 9.4-1. When available, the Trust Fund can provide low-interest loans, loan guarantees, and technical assistance to local jurisdictions for street and road, bridge, sanitary and storm sewer, and water system projects.

Table 9.4-1 summarizes pertinent data about the Public Works Trust Fund Loan Program.

#### Table 9.2-3 **Capital Improvement Costs** Revised 5-24-2010

							Estimated										
Project			Pipe Size			Completion	Cost in 2009										1
Code	Location	Project Type	(inch)	Length (LF)	Priority	Date	dollars	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
								1	2	3	4	5	6	7	8	9	10
Conveyance																	
C2	North Wenatchee Ave/Duncan Drainage Improvements	Conveyance	12	2,000	Long	2017	\$344,500								\$471,500		
C3	Western Avenue Drainage Improvements	Conveyance	18	3,190	Long	2018	\$590,000									\$839,800	
C4	Pershing Drainage Improvements	Conveyance	24	1,340	Long	2017	\$324,000								\$443,400		
C5	Filbeck Drainage Improvements	Conveyance	12	366	Long	2018	\$50,000									\$71,200	
C6	Seattle Drainage Improvements	Conveyance	12	1,276	Long	2017	\$163,500								\$223,800		
C7	Tacoma and Pine Drainage Improvements	Conveyance	12	1310	Long	2018	\$172,800									\$245,900	
C8	Ramona and Sunset Drainage Improvements	Conveyance	12	2,430	Long	2019	\$314,000										\$464,800
С9	Orchard Drainage Improvements	Conveyance	12	974	Long	2018	\$128,500									\$182,900	
C10	Kenaston and Linville Drainage Improvements	Conveyance	12	1,860	Long	2018	\$239,500									\$340,900	
C11	Marr and Margo Drainage Improvements	Conveyance	12	2,540	Mid	2012	\$325,500			\$366,100							
C12	South Wenatchee Drainage Improvements	Conveyance	12	1,686	Short	2011	\$221,500		\$239,600								
C13	Skyline Drive Drainage Improvements	Conveyance	12, 18	3,800 1,341	Long	2019	\$696,000										\$1,030,300
C14	Horse Lake Road Drainage Improvements	Conveyance	12	4,020	Long	2018	\$521,900									\$742,800	
C15	Poplar Drainage Improvements	Conveyance	12	660	Long	2019	\$84,000										\$124,300
C16	Methow Drainage Improvements	Conveyance	12	1,670	Long	2018	\$219,600									\$312,600	
C17	Day Road Drainage Improvements	Conveyance	12	2,520	Long	2017	\$323,500								\$442,700		
		•					Sub-Total =	\$0	\$239,600	\$366,100	\$0	\$0	\$0	\$0	\$1,581,400	\$2,736,100	\$1,619,400
	Extension																
E1	Walnut Drainage Extension	Extension	12, 18	1,560 1,660	Long	2018	\$448,000									\$637,600	
E2	McKittrick Drainage Extension	Extension	12, 18, 24	1,700 2,520 1,320	Long	2018	\$844,000									\$1,201,300	
E3	Maple Street Drainage Extension	Extension	12	614	Long	2018	\$79,500									\$113,200	
E4	Springwater Drainage Extension	Extension	12	2,550	Long	2018	\$330,000									\$469,700	
E5	South Hills Drive Drainage Extension	Extension	12	1,840	Long	2018	\$237,500									\$338,000	
E6	Avenida Drainage Extension	Extension	12	464	Long	2018	\$63,500									\$90,400	
E7	Squilchuck Drainage Extension	Extension	12, 18, 24	2,080 820 350	Long	2018	\$454,000									\$646,200	
E8	Jennings Drainage Extension	Extension	12	1,135	Long	2018	\$149,000									\$212,100	
E9	Ione and Maxine Drainage Extension	Extension	12	2,182	Long	2018	\$285,000									\$405,600	1
							Sub-Total =	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$4,114,100	\$0
Water Quality Facility																	
WQ3	Decant Facility	Water Quality	n/a	n/a	Long	2019	\$500,000										\$740,100
							Sub-Total =	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$740,100
	Replacement Projects																
R1 (C1)	North Miller Drainage Improvements	Conveyance	72	1,603	Long	2018	\$1,430,000									\$2,035,300	1
R2 (C18)	North Wenatchee Stormwater Facility Improvements	Conveyance			Mid	2013	\$100,000				\$117,000						1
R3 (WQ1)	Snow Melt Water Quality Facility	Water Quality	n/a	n/a	Short	2011	\$300,000	\$156,000	\$162,250								1
R4 (WQ2)	Linden Tree Phase II	Water Quality	n/a	n/a	Mid	2013	\$250,000				\$292,500						1
	Miscellaneous Replacement Projects									\$105,419		\$228,043	\$296,456	\$369,978			1
								\$156,000	\$162,250	\$105,419	\$292,500	\$228,043	\$296,456	\$369,978	\$0	\$2,035,300	\$0
				Annı	ual Total C	apital Improvem	nent Projects =		\$401,850	\$471,519	\$292,500	\$228,043	\$296,456	\$369,978	\$1,581,400	\$8,885,500	\$2,359,500
7 tillidar Total Suprial Improvement i Tojecto -							¥.03/000	<b>4.01/000</b>	4.7.17017	<i>\$2,2 000</i>	<del>+</del> 225/010	<del>+</del> 2,3,100	4007/770	Ţ.,031,100	40,000,000	42/007/000	

Notes: 1. Costs are planning level estimates and conceptual in nature. Costs are based upon 2008 and 2009 historical bid information for the Wenatchee Area including the Rock Island Road Reconstruction project for the City of East Wenatchee and the Riverside Drive Project for the City of Wenatchee.

<sup>2.</sup> Pipe construction costs are based on the pricing detailed in Table XX.

<sup>3.</sup> Paving and trenching costs are based upon City requirements for trench patch sections that were averaged into a linear foot cost based upon the diameter of the pipe and anticipated trench patch width.

<sup>4.</sup> Structure costs were further developed as individual structure costs inclusive of all installation costs and were assumed to be located every 300 feet along the length of the pipe.

<sup>5.</sup> Miscellaneous replacement projects will be identified through inspection of the stormwater system.

<sup>6.</sup> Costs have been escalated based on 4% increase in construction costs per year.

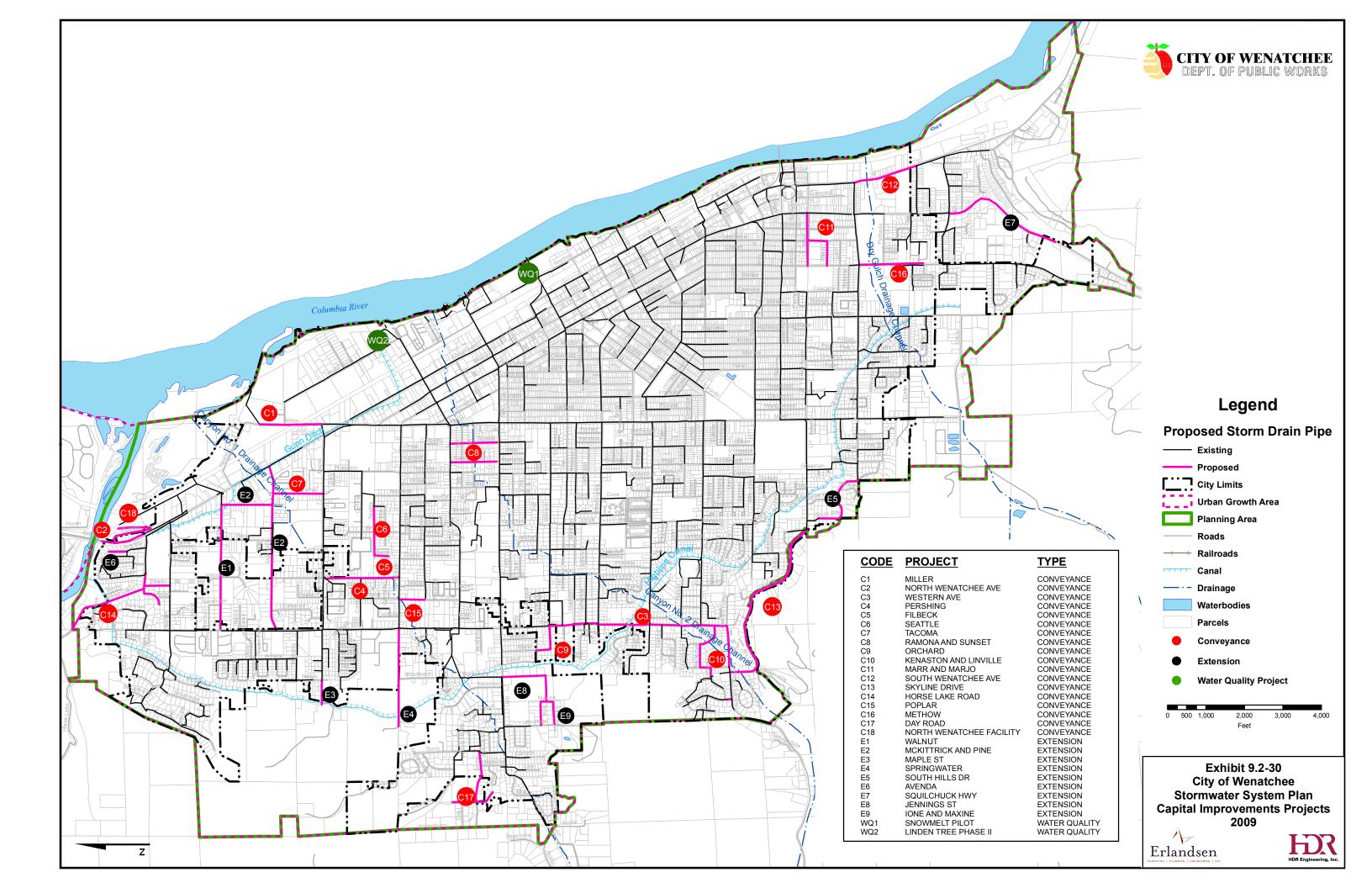


Table 9.4-1 Information about Public Works Trust Fund Loans									
Туре	Maximum Award	Approximate Application Deadline	Award Notices	Interest Rate Options	Term				
Pre- Construction*	\$1 million/ biennium	5 <sup>th</sup> day of each month	Upon Board approval (meet monthly)	0.5%–2% linked to local match (local match 5%–15%)	5 years, or 20 years with proof of construction financing				
Construction*	\$10 million/ biennium	May (annual)	Upon legislative approval (following spring)	0.5%–2% linked to local match (local match 5%–15%)	Life of the project or 20 years maximum				
Planning*	\$100,000/ biennium	5 <sup>th</sup> day of each month	Upon Board approval (meet monthly)	0% and no local match	6 years				
Emergency	\$500,000/ biennium	5 <sup>th</sup> day of each month	Upon Board approval (meet monthly)	3% with no local match	Life of project, or 20 years maximum				

Note: There are no reserve assignments in addition to basic debt service coverage in user rates for loans secured under PWTF financing.

## 9.4.2 Washington State Public Works Board Grants

During the 2009 legislative session, the state legislature established and funded two new grant programs: the Small Communities in Rural Counties Grant Program and the Urban Vitality Grant Program.

Wenatchee might be eligible for the Urban Vitality Grant Program, which is available for local governments that serve high-density urban communities. Eligible projects decrease per-capita vehicle-miles driven within the community by increasing access to mass transit, and:

- Support residential density in proximity to employment opportunities;
- Improve the safety and appeal of walking and biking in a community.

These projects can include relocating utility infrastructure in conjunction with roads or sidewalks. They must include construction elements. Project requests have no maximum, only a minimum of \$100,000 per jurisdiction. This could be an opportunity to fund low-impact development features while reducing stormwater flows (see Section 9.4.3).

<sup>\*</sup>The legislature did not fund these programs in its 2009 session.

## 9.4.3 Washington State Centennial Clean Water Grant, State Revolving Fund Loan, and Stormwater Retrofit and Lid Grant

Funds are provided from state and federal EPA sources for water quality improvement projects, including stormwater projects. Ecology administers these grants and loans. Funds can be used for upgrading, repairing, or retrofitting existing storm sewer facilities. Awards are generally targeted to project(s) that are not complying with water quality statutes or that need upgrades to meet emerging regulatory requirements, but other projects can also be funded.

For Centennial Clean Water Fund (CCWF) grants, hardship communities can apply for up to \$5 million. Additional CCWF grants are available for non-hardship communities for up to \$500 per project for non-regulatory stormwater projects. Funding is available for stormwater retrofits and low-impact development (LID) projects. The stormwater retrofit and LID grants require a 25 percent match.

Table 9.4-2 summarizes pertinent data about the State Revolving Fund Loan, Centennial Clean Water Grant Program, and the Stormwater Retrofit and Low-Impact Development Loans.

Table 9.4-2 Available Information Regarding Centennial Clean Water Grant (CCWG) and State Revolving Fund (SRF) Loan									
Туре	Maximum Award	Approximate Application Deadline	Award Notices	Interest Rate	Term				
CCWG	\$5 million or \$500,000 (see narrative)	December 1, 2009	Late Winter	N/A	NA				
SRF Loan	Unlimited	December 1, 2009	Late Winter	Under revision, likely to be 60% of the tax- exempt municipal bond rate for 20-year loans (~3%) OR 30% of the tax-exempt municipal bond rate for 5-year loans	20 Years OR 5 Years				
Stormwater Retrofit and LID Grants	\$500,000, requires a 25% match	December 1, 2009	Late Winter	NA	NA				

Note: There is a 16.7 percent reserve assignment to be included in user rates along with basic debt service for SRF loans.

## 9.4.4 Municipal General-Obligation Bonds

Funding from issuing general-obligation bonds has been used by the City for financing stormwater facility improvements. General-obligation bonds are issued by commercial sources and are not as attractive as state and federal sources of financing due to coverage requirements. However, general-obligation bonds are available from commercial sources, and they can be used for almost any city improvement, so eligibility

is not a concern. General-obligation bonds also work very well with Public Works Trust Fund financing to provide the local match required; they also lower the PWTF interest rate by 0.5 percent.

Table 9.4-3 summarizes pertinent data about financing using municipal generalobligation bonds.

Table 9.4-3 Applicable Information about Municipal General-Obligation Bond Financing										
Туре	Maximum Award	Application Window	Award Notices	Approximate Interest Rate	Term					
Municipal Bond	Unlimited	Any time	Subject to review of capacity	Varies	Up to 20 years, depending on the life of the improvements					

Notes: There is usually a 10 to 25 percent reserve assignment to be included in user rates along with basic debt service per municipal bond covenants. An application or point fee is also often charged up front, or upward adjustments are made in long-term interest rates.

## 9.4.5 Community Development Block Grant Funds (CDBG)

Funds are provided by the U.S. Department of Housing and Urban Development (HUD). Wenatchee is an "entitlement community" in a "non-entitlement" county. Thus, grant funds are provided by HUD directly to Wenatchee for the City to administer. Block grants can help develop and maintain public facilities and comprehensive projects that principally benefit low- and moderate-income citizens. The intent is to help eliminate slums and blight and resolve problems that pose an immediate threat to public health or safety.

An income survey might be required to determine the number of low- to moderate-income (LMI) families. To qualify, the percentage of LIM families within the project area must be more than 51 percent.

The City might want to consider using these funds for improvements to the public storm sewer system in low-income areas of the city.

## 9.4.6 Flood-Control Assistance Account Program (FCAAP Grant)

The Floodplain Management Section of Ecology administers the Flood-Control Assistance Account Program (FCAAP). FCAAP is a grant program that assists Cities and Counties with flood-control emergency and non-emergency maintenance and capital improvement projects. The maximum funding possible per county per biennium is \$500,000 for non-emergency grants and \$150,000 for emergency grants. Local matches of 20 percent and 50 percent are required for maintenance and emergency maintenance projects, respectively. The application cycle for this program is January–February of odd-numbered years.

The City could consider this program as part of a combined canyon drainage improvement and canyon flood hazard mitigation project. See Chapter 7 for additional information.

## 9.4.7 U.S. Army Corps of Engineers Funding Opportunities

Chapter 7 and Appendix G describe the Corps' funding opportunities and eligibility requirements.

# 9.4.8 Conversion of FEMA Flood Insurance Payments to Local Share Financing for Flood Hazard Mitigation

There are hundreds of existing parcels in the floodplains of Canyons No. 1 and No. 2 and Dry Gulch. If a parcel is developed and has a mortgage, the owner currently has flood hazard insurance. The vacant parcels do not have flood insurance. However, once development is proposed, flood insurance will be required. Once insurance is in place, the insurance premium must be paid annually until the mortgage is paid off. It is probable that each existing parcel will have a total of \$7,500 in flood insurance premiums over a 15-year mortgage period, or double that amount if mortgages are extended to 30 years.

If canyon flood hazard mitigation is implemented from the options identified in Chapter 7, the properties that are currently in the floodplain could be removed from the floodplain entirely by constructing flood mitigation projects. Once the flood hazard is removed, the FIRMs could be amended and the requirement for flood insurance removed.

As a condition of sponsoring the project, the City could propose a local improvement district to cover all existing floodplain properties. The improvement district would likely be used to cover a portion of expenses to improve the canyon drains through the urban area.

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